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# Joyst

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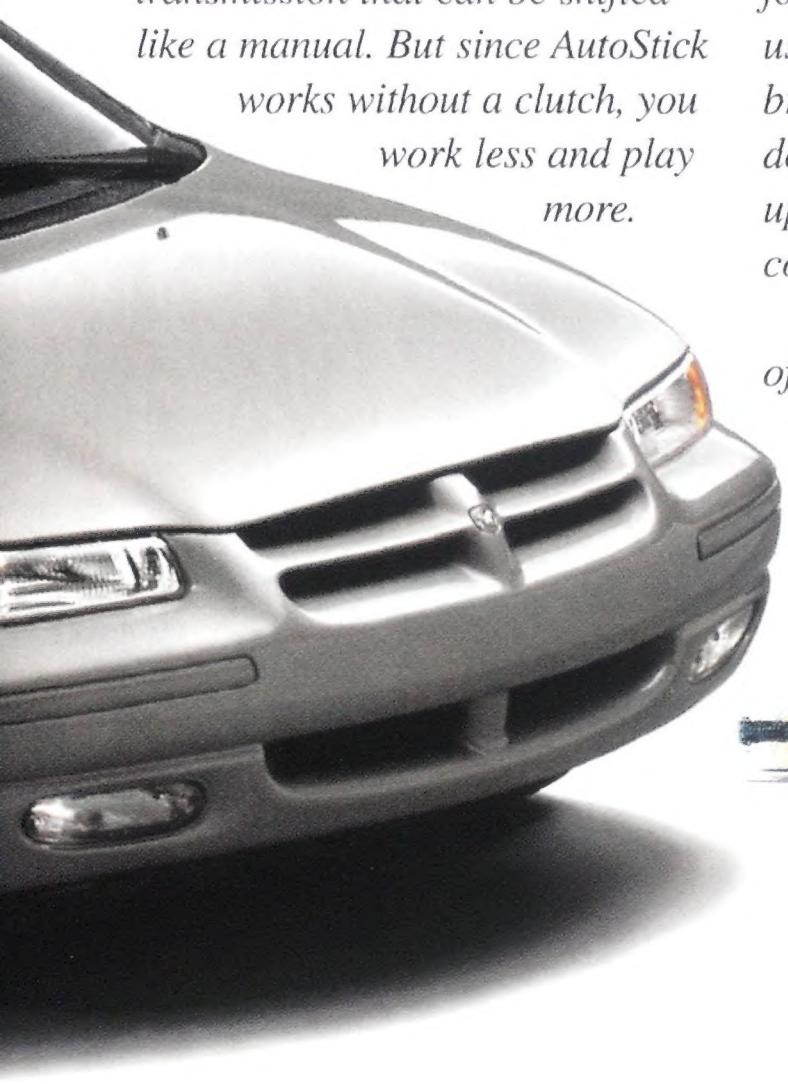

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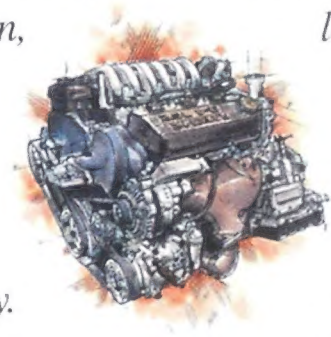

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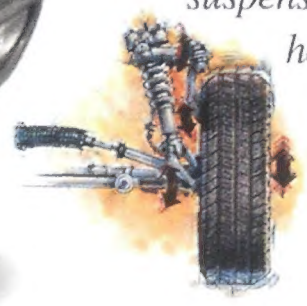

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Volume 12, Number 1

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*Illustration by David Peters*
*Join some of the superstars of the Reno Air Races—and a squadron of greats from air racing's Golden Age—for a victory lap around the desert.*


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*Cover:*
*Eric Schulzinger photographed Lockheed Martin's F-22 prototype in Georgia. The production version debuts this spring.*

*Departments*



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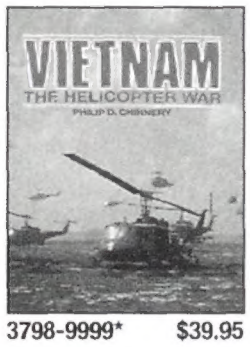


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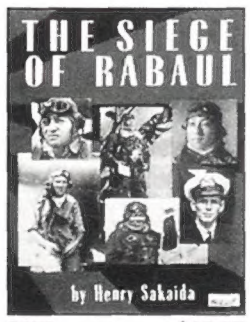


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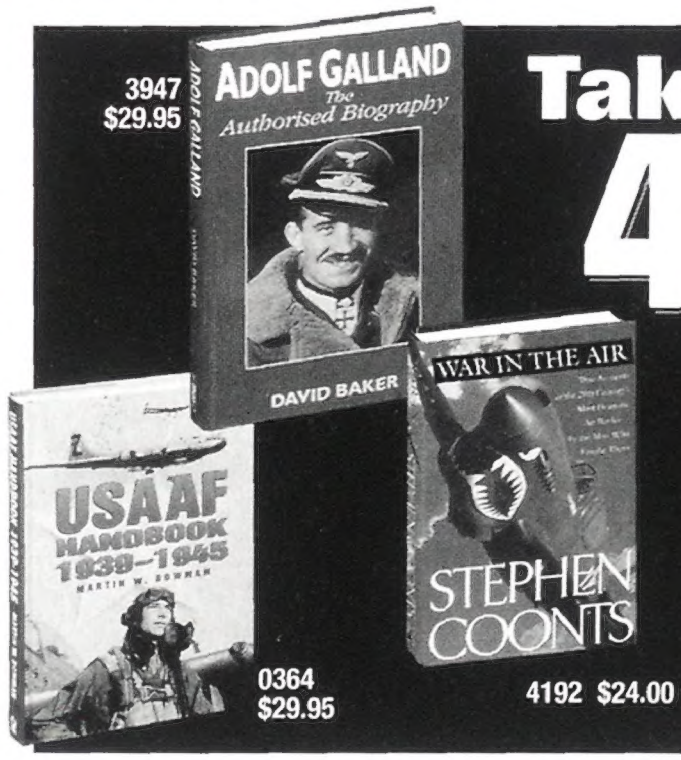



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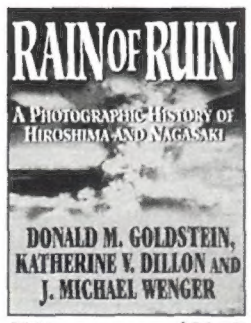


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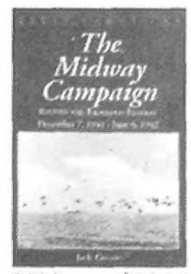


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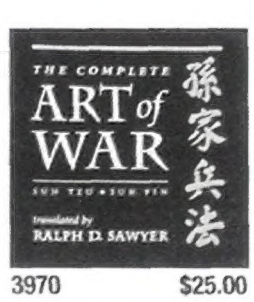


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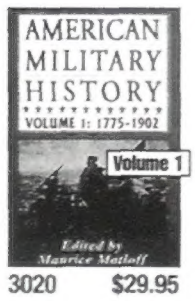


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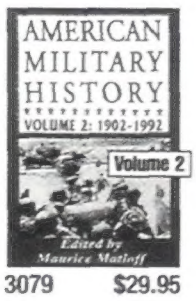


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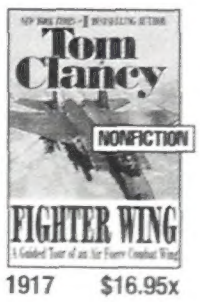


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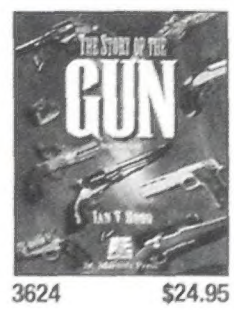


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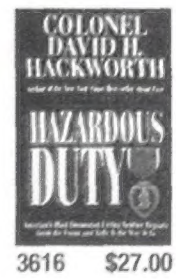


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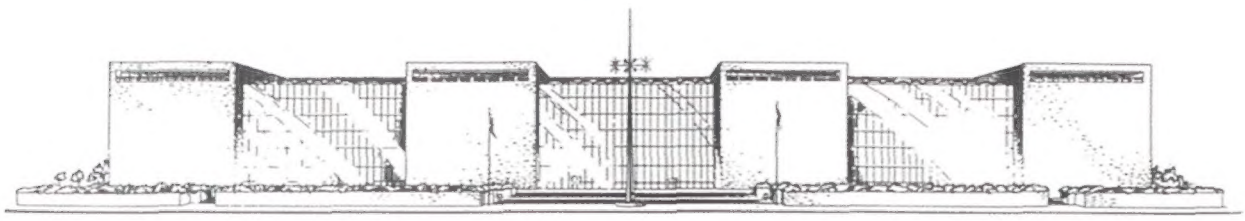

# On Earhart's Trail

Aviation and space histories are full of many rich and enduring events, as well as a few great feats. We at the National Air and Space Museum cherish and honor both the human and the technological achievements in aviation and spaceflight. We do this as a way of showing newcomers and oldtimers alike the milestones we have passed along the way. Such achievements come from the dreams and desires of people—pilots, astronauts, engineers, operators, philanthropists, and many others who either had a vision or supported another person's dream.

While we work to honor the past, the Museum does not just look backward. We focus on the quests of today and look to the future for inspiration and new but still distant goals.

In our Milestones of Flight gallery, we honor among others the Wright brothers and their *Flyer*, Charles Lindbergh and his *Spirit of St. Louis*, John Glenn and his Mercury capsule *Friendship 7*, James McDivitt and Ed White and their Gemini 4 spacecraft, and Neil Armstrong, Buzz Aldrin, and Michael Collins and their Apollo 11 command module.

In our large Space Hall, we have, among other artifacts, the Skylab manned orbiting laboratory and the proof-of-concept model of NASA's Hubble Space Telescope. That instrument captured our attention when it was serviced last February by crew members of the space shuttle *Discovery*.

Recently, the Bell Boeing Team unveiled their joint model 609, the civil tilt-rotor airplane concept of tomorrow, in our Air Transportation gallery. Our Beyond the Limits gallery pays homage to the nation's quest for answers to new aerospace challenges and stresses the importance of the engineering test pilot and the flight test engineer.

As you read this, you will probably be following a singular current effort by a pilot hoping to re-create and complete the around-the-world flight Amelia Earhart once attempted. The plans call for Linda Finch to take off from Oakland, California, on March 17, 1997, exactly 60 years to the day after Earhart began her eastward flight. Like Earhart, Finch will fly a Lockheed 10E, and she will follow, as closely as possible, Earhart's intended flight path, modified only as necessary by today's regional unrest and international political situation.

Other women have flown around the world since Earhart first tried, but Finch is drawing attention to that first attempt. Just as Earhart was assisted by a navigator, Finch will employ several rotating navigators who have volunteered their time away from jobs and responsibilities to take part in the project, estimated to take two and a half months.

Finch's flight is sponsored by the aircraft engine firm Pratt & Whitney, maker of the Lockheed 10E's original Wasp engines. Today's communications technology will enable children in U.S. middle schools, as well as grownups, to follow her flight and get involved in the learning and excitement of the project, "World Flight 1997."

Recording the events on film will be a crew flying in another intrepid airman's amphibian. Reid Dennis of Burlingame, California, has volunteered his Grumman SA-16 Albatross along with his crew and his services as pilot to photographically record Finch's effort. Reid and his crew will have their own challenges.

I know of no major achievement in aviation or manned spaceflight that did not ultimately depend upon the determination, guts, and bravery of the pilot or astronaut to see his or her goal through. We at the National Air and Space Museum will follow Finch's effort and enable visitors here to connect to her Web page and check her daily progress.

This flight presents an opportunity for the commemoration of aviation history, and demonstrates again the importance of training, vision, and determination of pilots and astronauts in achieving major goals. We all wish Linda Finch well!

*—Don Engen is Director of the National Air and Space Museum.*

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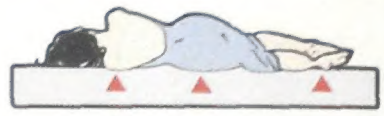

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# LETTERS

## An Even Earlier Aerial

"Portraits by Mayfield" (Feb./Mar. 1997) suggests that the picture William Mayfield took of Simms Station in November 1910 may have been the first aerial photo taken in the United States.

My grandfather, George E. Prentice, took a photograph from a Wright "aeroplane" a month earlier. On September 30 he went up for a ride with barnstormer Al Welch at the Bridgeport Aerodrome in Connecticut, and got a photograph of the aerodrome's grandstand. It appeared the next day in the *Bridgeport Post*.

—Prentice M. Troup
Washington, North Carolina

## Quit Talking Trash

I am disgusted and angered by "Burial at Sea" (Dec. 1996/Jan. 1997) and at the military's "public be damned" attitude, demonstrated by its dumping used A-6s in the ocean like so much trash.

The smartaleck subhead of your article asks: "...what could be a more fitting end?" How about turning the planes into monuments to be displayed in front of city halls, Elks lodges, public buildings, and any of the thousands of other places that would be honored to pay continuing tribute to the brave men who flew these planes, and the noble birds themselves?

Maybe there should be a law stating: "Airplanes should not be tossed in the drink until the responsible authorities have exhausted every effort to find a nobler end for them."

In the event you have the guts to print this letter, I insist that my name and address be withheld.

## NASA: Take a Stand

I am thrilled with the restoration of the Saturn V rocket ("Saturn Rising," Dec. 1996/Jan. 1997). However, I visualize a Saturn V displayed standing vertically on a launch pad or transporter, complete with its umbilical tower. Imagine being


*"That must be one of those 'trial balloons.' "*

*"Well, Baxter, I hope THIS time you remembered to mail in the warranty card."*

able to walk beneath this giant as it once stood waiting for the journey to the moon.

—Kim Pedersen
Fremont, California

### Losing Gravity Over Russia

"G Whiz" (Soundings, Feb./Mar. 1997) reports that a Florida facility will become "the second to offer zero-G rides." We believe that honor belongs to us. Incredible Adventures (formerly known as MIGS etc.) has been offering zero-G flights in the Russian space agency's IL-76 MDK for more than two years.

—Jane Reifert
President, Incredible Adventures, Inc.
Sarasota, Florida

### The Fall of Harriet Quimby

Harriet Quimby did not die in a plane crash ("I'm Just Wild About Harriet," Soundings, Feb./Mar. 1997). On July 1, 1912, she and her passenger, William Willard, were thrown from her open-framework Blériot at an estimated altitude of 1,500 feet. Her aircraft had better luck, landing almost undamaged.

—R.P. Gordon
Plainfield, New Jersey

### A Dark History

In "Escape to U Taphao" (Dec. 1996/Jan. 1997) the author quotes Air Force Brigadier General Harry Aderholt as recommending one history of the Vietnam war because "it shows what bastards we are. How we always desert our allies." From 1965 to 1968, I was a pilot and later a squadron leader on aircraft carriers, and the lack of political leadership in the war was clear. I would be pleased to read something authoritative on the issue, such as the book General Aderholt referred to. What is it?

—Commander Marvin Quaid
U.S. Navy (ret.)
Monterey, California

*Editors' reply: The book is* Back Fire: The CIA's Secret War in Laos and Its Link to the War in Vietnam *by Roger Warner (Simon and Schuster, 1995).*

### Show Some Respect

I was disappointed to see my job described as "lowly" first officer ("From Commander to Copilot," Soundings, Feb./Mar. 1997). Flying "missions" with over 100 souls depending on my abilities and training, I have as much responsibility as a shuttle commander like Hoot Gibson. I am honored he has chosen to do what I do.

—Marc D. Bedrosian
Wheaton, Illinois

### Corrections

*Feb./Mar. 1997* "One Good Year": The airfield in the photograph on the top of p. 80 was located in Burbank, California, not Salt Lake City.

"Gary and the Pirates": The ammunition removed from the B-17 was .50 caliber, not 50-mm.

Sightings: All photographs were taken by Chad Slattery (the first was erroneously credited to George Hall).

Reviews & Previews, *An Exhibit Denied*: (1) At the time of the Hiroshima bombing, Paul Tibbets was a full colonel, not a lieutenant colonel. (2) W. Burr Bennett Jr. was an enlisted man with an aerial photographer classification, not a reconnaissance officer.

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### The Lowdown on "High Flight"

I have discovered that some of the most memorable lines of John Gillespie Magee Jr.'s oft-quoted sonnet, "High Flight" ("The Annotated 'High Flight,' " Aug./Sept. 1996), contain the work of other poets.

It is my guess that Magee had read the poems he borrowed from in the book *Icarus, An Anthology of the Poetry of Flight*, which was published in 1938, three years before Magee wrote "High Flight."

In the following list, I compare, respectively, Magee's phrasings with wording in poems appearing in *Icarus.*

"surly bonds of Earth"
"earth fetters and the shackling sea"
*(from "New World" by G.W.M. Dunn)*

"danced the skies"
"danced the streets of heaven"
*(from "The Blind Man Flies" by Cuthbert Hicks)*

"on laughter-silvered wings"
"on laughter-silvered wings"
*("New World")*

"shouting wind"
"shouting of the air"
*("New World")*

"with silent, lifting mind"
"hushed limbs and the lifting mind"
*("New World")*

"untrespassed sanctity of space"
"unpierced sanctity of space"
*("Dominion Over Air" by C.A.F.B.)*

"and touched the face of God"
"And touched the face of God"
*(last line of "The Blind Man Flies" )*

To be fair, Magee's sonnet is very much of its time; references to eagles, silence, halls or vestibules, and God abound in many poems of the era. Even Magee's "footless halls of air" was not necessarily inspired by Frederick V. Branford's "footless levels of the night" (from the poem "Night Flying"). The word "footless" was simply more common back then.

We shall presumably never know whether Magee was conscious of his plagiarisms. "High Flight" was written quickly, and that rapidity could account for some unconscious plagiarism. But so much?

—Tony French
Dunkeswell, Devon, United Kingdom

*Editors' note: More information on French's research appears in the March 1997 issue of the British magazine* Pilot.

# Saturnalia


"It's been 24 years, 31 days, seven hours, and 46 and a half minutes...since a man last stood on the moon," the tuxedoed emcee pointed out. And now that man, Eugene Cernan, was one-upping Buzz Aldrin, the man who stood second.

"He didn't spend the night," Cernan reminded a crush of photographers pointing cameras at the pair. "Not a real night, no," Aldrin allowed, "but we got sleep—about six hours."

"We slept in hammocks," Cernan said. "Did you have hammocks?"

It was quintessential cocktail conversation for the 11 Apollo astronauts who appeared in black tie and rose boutonnieres at a January gala to celebrate the opening of the $37 million Apollo/Saturn V Center at NASA's Kennedy Space Center in Florida.

The 100,000-square-foot building houses a variety of Apollo artifacts: the spacesuit in which Jim Lovell braved the extremes on the aborted Apollo 13 mission, a lunar module swaddled in gold Mylar, a command module polished to a mirror-like shine, and the main attraction, a 363-foot Saturn V moon rocket, one of only three remaining in the world. Recently moved from an outdoor location near Kennedy's mammoth Vehicle Assembly Building, the restored colossus rests on its side in a cradle of steel I-beams (see "Saturn Rising," Dec. 1996/Jan. 1997).

There's ample room to stroll beneath the Saturn V and gawk at its gargantuan features. On this night, a costumed spaceman mingled with guests on the Rocket Plaza. String and woodwind melodies competed with the cacophony of voices along that concourse, where a smorgasbord stretched forever.

Apollo Ale, a special brew in a cobalt blue bottle with a cresent moon, captivated the guests as much as anything except, perhaps, the sight of one another in formal wear in a kingdom where polo shirts and jeans reign supreme. Bob Sieck, director of space shuttle operations at Kennedy, protested in one breath: "I look ridiculous," while confessing with the next: "This is a good-looking bunch. It's nice to get all gussied up once in a while."

Ten Apollo astronauts—Buzz Aldrin, Bill Anders, Gene Cernan, Walt Cunningham, Charlie Duke, Dick Gordon, Ed Mitchell, Rusty Schweickart, Tom Stafford, and John Young—posed for a class picture before the festivities began. Jack Schmitt came along in time to be introduced during a ceremony.

Reclusive Neil Armstrong was a no-show, except for a videotaped cameo in a 12-minute reenactment of the first moon landing. "Perhaps that's the greatest legacy of Apollo," he said. "It shows our children and grandchildren that with courage, imagination, and the will to explore, no dream is impossible."

Veteran shuttle commander Frank Culbertson, currently directing U.S. visits to the Russian space station Mir, escorted four cosmonauts. Several other shuttle astronauts in military dress were as excited as autograph hounds to meet Apollo veterans.

Young, a Gemini, Apollo, and shuttle veteran with seven launches logged, elicited screams, whistles, applause, and a sea of raised hands when he asked the audience: "For my own education: How many people wish we were going back to the moon?"

*—Beth Dickey*

NASA (2)

CORBIS-BETTMANN

### *Belles Lettres*

The two huge relics from a once-mighty empire are stored deep inside a New Jersey warehouse. The objects, the 15-foot-tall blue plastic letters "P" and "A," are all that remain of the words that for nearly 30 years glowed from the summit of Manhattan's dark, monolithic Pan Am Building before it became the dark, monolithic Met Life building in 1992.

"Most of the letters were beyond salvation," says Jeff Kreinder, director of the Pan Am Historical Foundation. "They were decrepit and broken up in the process of removing them." But the "P" and the "A" were deemed savable for posterity.

Workers charged with removing the letters from the top of the 808-foot office tower and replacing them with "Met Life" had to deal with more than just eight million New Yorkers disgruntled over seeing another beloved landmark being renamed. They also had to contend with a pair of nesting peregrine falcons, an endangered species with an attitude. "Every day the men would come to work and on our scaffolds would find pigeon heads," says Sol Sachs, vice president of sign manufacturer Universal Limited. "The falcons are rather large and they wanted to make sure we didn't miss them. We did them no harm and they did us no harm."

The plan is to eventually move the falcon-free letters to Florida, where an as-yet-conceptual museum will honor the airline. "Speculation at this point is that it is possible to display the letters outside the museum exterior, or they could be set up relative to pictures of the Pan Am building," Kreinder says. Ready and waiting in Florida: the two 25-foot-wide globe logos that once graced the tower's east and west facades. Each, Sachs assures us, survived in one piece.

*—Phil Scott*

### *Stardust Memories*

Chan Tysor takes a deep breath, holds it, and taps gingerly on the side of a small glass cylinder. Something resembling beach sand—tiny white pebbles mixed with fine gray powder—spills out of the open vial. The red digits of a postal scale climb to precisely seven grams as the gritty dust makes a little mountain in a paper tray.

"It's very sacred material," Tysor, president of Celestis Inc., says solemnly as he rolls the paper into a funnel and pours the stuff into a tube about the size of a lipstick. The tube's aluminum coating is engraved with a message: "Life is not measured by length but depth."

He screws on a black plastic cap, and with that, the cremated remains of 42-year-old Air Force Captain Charles William Slack III are encapsulated for a trip into Earth orbit. Slack is passenger number 25 on history's first space burial flight (see "Dollars from Heaven," June/July 1986).

A symbolic portion of Slack's ashes, along with those of 24 others, are loaded aboard a Pegasus rocket, which Orbital Sciences will launch this spring from a Lockheed L-1011 over the Canary Islands.

Friends and relatives of the departed paid $4,800 each for the opportunity to memorialize their loved ones. The service doesn't include cremation, but survivors will receive a keepsake video documenting the payload preparation and the launch.

The flight has been years in the making. Conceived in the mid-1980s by


*This July, the U.S. Postal Service will release a commemorative sheet of stamps entitled "20 Classic American Aircraft." "When you pick 20 from thousands of possible airplanes you're not going to please everybody," says Barry Ziehl of the Postal Service, "but we certainly were trying to have a broad representation." The project designer was* Air & Space/Smithsonian *design director Phil Jordan; the aircraft were selected by* Air & Space *founder Walter Boyne and rendered by artist Bill Phillips. "Walter suggested six guidelines for each plane's selection," says Ziehl. "Its importance to aviation history, contribution to technology, public perception, aesthetic appeal, standard of excellence, and distinctive, evocative appearance."*

Left to right: Curtiss Model D, North American F-86 Sabre; North American P-51 Mustang, Wright Model B, Piper J-3 Cub, Lockheed Vega; Northrop Alpha, Martin B-10, Vought F4U Corsair, Boeing B-47 Stratojet; Gee Bee Super Sportster, Beech Model 17 Staggerwing, Boeing B-17 Flying Fortress, Boeing Stearman; Lockheed Constellation, Lockheed P-38 Lightning, Boeing P-26 Peashooter, Ford 4-AT Tri-motor; Douglas DC-3, Boeing Model 314, Curtiss JN-4 Jenny, Grumman F4F Wildcat.

some funeral directors and an aerospace engineer in Florida (and envisioned as early as 1965, in the film *The Loved One*), the idea was grounded by regulatory red tape before it was finally brought to fruition in Texas by 14 entrepreneurs who invested less than $1 million to get the business started again.

"Everybody knows about scattering at sea," says Charles Chafer, vice president of development for Celestis. "Some people do it out of hot-air balloons. We're a little bit unique for now, but anybody that's been interested in space all their lives and elects cremation is pretty naturally going to gravitate toward us."

Not much bigger than a beer can, the Celestis capsule will ride piggyback on the third stage of the booster that will loft Spain's first communications satellite. "The payload will remain in orbit between several months and several years (depending on the orbital parameters) and eventually will reenter the atmosphere, completely vaporizing and essentially scattering the ashes in space in an

CHRISTOPHER CORMACK(©)

environmentally benign manner," company literature states. "There are no thermal requirements, no power requirements, no specific orbit requirements, so we fit very nicely with Orbital's interests in selling some extra space that they have, and that was a real breakthrough in terms of being able to offer the service," Chafer says.

This first launch is called the "founder's flight." Among the 25 souls on board are aerospace luminaries Benson Hamlin, design engineer for the Bell X-1; John Kenneth Sterrett, scientific advisor to NASA and NORAD (North American Air Defense); Krafft A. Ehricke, German space scientist and philosopher; Gerard K. O'Neill, space visionary and author of *The High Frontier*; and Todd B. Hawley, co-founder of the International Space University.

There's also Star Trek creator Gene Roddenberry, whose ashes orbited once before aboard the space shuttle. And there are two of the three founders of the original Celestis Inc., aerospace engineer Beauford Franklin and funeral director James C. Kuhl, as well as armchair astronaut John Patrick Boutilier of Greene, Maine, a restaurant manager who once told his wife he wished NASA would send him on a one-way mission to the stars. The most famous aboard is 1960s icon Timothy Leary, who imagined space as the ultimate trip.

To Chafer, the purchasers of the service are the true space pioneers. "Grief is a tough cycle to go through," he says, "but to be able to then turn around and help somebody, through their life, create more demand for space transporation—our folks love it."

*—Beth Dickey*

## UPDATE

### Transitions

Aviation model maker Bill Topping's dioramas, which depict some 75 years of aviation history ("The Model Man," Oct./Nov. 1996), have been acquired by the Santa Maria Museum of Flight in California and are scheduled to go on permanent exhibition this spring.

Astronomer Clyde Tombaugh, who discovered the planet Pluto in 1930 ("Is Something Out There?" Apr./May 1993), died at his home in New Mexico last January 17 at age 90.

P-47 pilot Roger Lane, who was shot down over Germany in 1944 and had been missing in action until his remains were discovered in 1993 ("Homecoming," Oct./Nov. 1995), was laid to rest next to his parents' graves in Yarmouth, Maine, early last January. He was buried with full military honors, including a color guard, honor guard, and a missing-man formation fly-over by Air National Guard F-16s.

### *Duxford Museum Nears Completion*

Historians and diplomats allude to the "special relationship" that has marked Anglo-American cooperation since World War I in peace and especially war. One of the most stirring tangible symbols of that relationship is nearing completion and is set to open August 1: the American Air Museum, located at Duxford, near Cambridge, England.

During World War II Duxford was home to the 78th Fighter Group of the U.S. Eighth Air Force: now it's the site of the new $17 million glass-walled museum, which will serve as home to more than 20 U.S. warplanes. A large portion of the funds to build the museum was raised by some 60,000 American founding members, including former flight crewmen Jimmy Stewart and Charlton Heston.

The collection of aircraft covers conflicts from World War I to Desert Storm and includes both Air Force and Navy types. The adjacent facilities of the Imperial War Museum include 180 aircraft along with the largest aircraft restoration center in the world.

Reflecting the importance of the opening to Britons, Queen Elizabeth will preside over the opening ceremonies in August, to which founding members will be invited. For information about how to become a founding member, U.S. callers can telephone (800) 233-4226.

*—George C. Larson*

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# The Human Face of the Space Race

Midway through her celebrated six-month stay on the Russian Mir space station last year, NASA astronaut Shannon Lucid was floating around the cabin with her cosmonaut crewmates one evening when the talk turned to their childhoods, and how Russians and Americans had perceived each other during the bad old days of the cold war. Lucid grew up in Oklahoma, and the "two Yuris," as she dubbed her colleagues Yuri Onufrienko and Yuri Usachev, had been raised in Russia and the Ukraine. "It dawned on all three of us at once," she later recalled, "how remarkable it was that here we were, three people who grew up in totally different parts of the world, mortally afraid of each other. Here we were sitting in an outpost in space together, working together, and getting along just great."

The often ironic, up-and-down history of U.S.-Russian relations in space—from cold war competition to Lucid's hug-filled visit to Mir—is aptly reflected in a new exhibit called "Space Race," which goes on permanent display in the National Air and Space Museum's Space Hall this May. (For a current view of the U.S.-Russian relationship, see "Commentary," p. 58.) What used to be a hodgepodge of artifacts in Space Hall has been focused and embellished to tell a coherent story of competition and cooperation between the world's two largest space powers. Along with rockets and spacesuits, Museum curators have displayed a nice selection of photographs, notebooks, and other items that show the human side of the story.

*Artifacts new to Space Hall include a doll autographed by cosmonaut Viktor Patsayev and a Soviet spacesuit (right).*

© SOTHEBY'S (2)

Fans of the old Space Hall will still find several familiar attractions, including the giant walk-through Skylab Orbital Workshop, which gives a glimpse of astronaut accommodations in the 1970s. A life-size test version of the Hubble Space Telescope has been refurbished and tilted on a cradle to look more like the real thing. And full-scale versions of the U.S. Apollo and Soviet Soyuz vehicles are still on display, linked together just as they were in space in 1995.

To these and other holdovers, Museum curators have added a timeline running across the walls of the gallery, and they've organized the displays around five themes: the military origins of rocketry, the race to the moon, exploring the moon, satellite reconnaissance, and a permanent presence in space.

But the addition of a large number of Soviet space artifacts is what really makes the new exhibit sparkle. Many of the items were sold to private owners at a 1993 auction at Sotheby's and are being displayed to large audiences for the first time. One of the principal buyers at the sale was former presidential candidate Ross Perot, who, during an earlier visit to Russia, had reportedly been appalled at the shabby way the country was preserving its space artifacts. The Perot Foundation put the cream of its collection into an exhibit that visited several U.S. military academies in the past two years and is now sharing its bounty with the nation.

The loans from Perot, plus those from

other donors, including an anonymous American who also scored big at Sotheby's, make for some arresting juxtapositions: Yuri Gagarin's training suit displayed next to American astronaut John Glenn's; an Apollo suit worn on the lunar surface alongside a Soviet "Krechet" suit, which was designed for the same purpose but never made it to the moon; and U.S. rocket engineer Wernher von Braun's slide rule next to one used by his Soviet counterpart, Sergei Korolev (both are the same German make—Nestler).

The space race had a covert side, and the exhibit documents it with a display of the camera from a 1960s-era U.S. Corona reconnaissance satellite (loaned by the CIA) next to a Soviet Merkur spacecraft also used for spying. The display includes film-return capsules used by each side in the top-secret reconnaissance missions of the cold war, along with pictures of the Pentagon and the Kremlin.

Visitors are likely to find that it is the Russian objects—not the American—that best embody the drama and potential danger of spaceflight. Tucked in a corner near the Apollo-Soyuz spacecraft is the Soyuz TM-10 three-man capsule, its charred hull evidence of its successful return to Earth in 1990. Stenciled on the side is a diagram and a message (in both Russian and English) to anyone who might find the capsule after its reentry: MAN INSIDE! HELP! OPEN THE HATCH! TAKE THE KEY! PUT INTO THE HOLE!

A somewhat eerie new artifact is a cosmonaut mannequin, nicknamed "Ivan Ivanovich," that flew in space aboard a Vostok capsule just weeks before Gagarin's historic April 1961 flight. The Moscow Prosthetic Appliances Works, which built the mannequin, made it so lifelike that Sergei Korolev had to order it marked "model" to keep from unsettling his space engineers.

These early Soviet artifacts tell of a time when Earth orbit was still the province of pioneers. There is the flightsuit worn by cosmonaut Konstantin Feoktistov on Voskhod 1 in 1964; the suit kept him warm, but it would have offered him no protection from the vacuum of space in the event of a depressurized cabin (there wasn't enough room on board the jury-rigged, three-man craft for pressure suits). Also on display is Feoktistov's survival knife. The members of the Voskhod crew launched after his were happy to have such equipment: Their capsule landed 2,000 miles off course in a snow-covered Russian forest, and they had to spend the night fending off wolves.

The crew of Voskhod 2 survived, but not all of the early Soviet space travelers would be so fortunate. In June 1971, the three-man crew of Soyuz 11 died when their spacecraft depressurized during its reentry into the atmosphere. Before he left Earth, Viktor Patsayev, one of the Soyuz 11 crew, played a joke on his friend and fellow cosmonaut Georgi Grechko, who was staying at the same hotel in the space center. On the back of a children's doll given to Grechko by his wife, Patsayev signed his own name and wrote a message stating that he had "stayed at this hotel 1969–1971." Since it was considered bad luck for a cosmonaut to sign autographs before a flight, Patsayev postdated his message by a month. Grechko discovered it only afterward.

The doll, and other mementos like it, make the new "Space Race" exhibit a poignant reminder of the Russian space program's uncommon soulfulness.

*—Tony Reichhardt*

## *Museum Calendar*

*Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700; TTY: (202) 357-1729.*

**April 10** "Ace of Two Wars." Colonel Francis S. Gabreski, USAF (ret.), talks about his combat experiences during World War II and the Korean war. Langley Theater, 7:30 p.m.

**April 16** "Mission to Planet Earth." Robert Price, associate director of NASA's Mission to Planet Earth office, discusses his agency's plans to examine our planet. Einstein Planetarium, 7:30 p.m.

**April 26** "Sky-Shooting." Geoff Chester, an astronomer at the National Air and Space Museum, shares his experiences capturing the night sky on film and videotape. Einstein Planetarium, 6 p.m.

**April 30** "The Red Planet Revealed." Donna Shirley, manager of the Mars Exploration Program Office at the Jet Propulsion Laboratory, will review our changing perceptions of Mars. Langley Theater, 8 p.m.

**May 22** Charles A. Lindbergh Memorial Lecture. Reeve Lindbergh, daughter of Charles Lindbergh, will share remembrances of her father on the 70th anniversary of his historic solo flight across the Atlantic. Langley Theater, 8 p.m.

### *National Air and Space Society*

As a member of the National Air and Space Society, you will help in the Museum's efforts to build an extension at Dulles International Airport, which will display such artifacts as an SR-71 Blackbird and the space shuttle *Enterprise*. To receive additional information, call (202) 786-2643 or write to the National Air and Space Society, NASM, Room 3520-B, MRC 310, Washington, DC 20560.

CAROLINE SHEEN


*Last fall artist Stephen Gonyea painted a mural on the north wall of Gallery 104 in honor of the U.S. Air Force's 50th anniversary, which the National Air and Space Museum is celebrating throughout the year. Gonyea's mural depicts six North American F-86 Sabres over South Korea, evoking the air battles of the Korean war, in which Air Force F-86s shot down enemy MiGs by the hundreds.*

# Odorless, Colorless, Blameless

It's a lonely stance, being the only spacecraft operator at NASA's Kennedy Space Center who's also a "helium head"—a fan of lighter-than-air craft. Guys in the Orbiter Processing Facility feign terror when a tank of pressurized hydrogen is rolled by for testing the space shuttle's fuel cells. "O the humanity!" they quip, and I shoot back with the words of a 1906 opponent of heavier-than-air craft who compared such travel to putting out to sea on a ship that required an engine to keep it afloat.

About two years ago I was seeking information on hydrogen's energy content by weight when I crashed the International Association of Hydrogen Energy conference in Cocoa Beach, Florida. But when I explained my longtime interest in using the gas for airship engine fuel, some engineers smiled wryly and asked if I'd ever heard of something called the *Hindenburg*—the airship whose spectacular destruction 60 years ago this May in a fire believed to be caused by its hydrogen lifting gas essentially ended air travel by zeppelin. Then I bumped into Addison Bain, recently retired after a career managing NASA's hydrogen fuel programs. He asked me the same question—but he wasn't being sarcastic.

Over lunch, Bain explained that his research had led him to conclude what those familiar with hydrogen had long suspected: that hydrogen played little or no part in starting the *Hindenburg* fire. When you watch footage of the fire, he said, what you see burning is actually the LZ-129's outer covering. Indeed, he speculated that the airship's fabric skin, if peeled off, rolled in a scroll, and crammed in a pipe, would make a solid rocket not unlike what we use to get the shuttle off the pad.

*Wow*, I thought. Designed for non-extinguishable continuous combustion, the shuttle's solid rocket boosters burn aluminum fuel, which releases oxygen from its perchlorates. The *Hindenburg* was wrapped with over six acres of doped cellulose material impregnated with aluminum. Witnesses had described the brilliant colors of the airship's fire as reminiscent of an impressive fireworks display; it had never occurred to me to look at it as a rocket instead.

I went home and opened a book on the *Hindenburg*. As I studied one of the famous images of the zeppelin aflame, it suddenly appeared obvious. The smoking fire is burning *downward*, even on the gasless fins' underside. Bain had pointed out that hydrogen would burn upward—with no smoke. Then, as I continued to study the picture, it dawned on me: The 242-ton vehicle was still aloft even as the gas that kept it there had supposedly exploded.

Suddenly it was like knowing how a magician's trick was performed. I could see clues to the illusion all around me. I loaded a laser disc of the 1975 disaster movie *The Hindenburg* and advanced through its interspersed newsreel footage

NATIONAL ARCHIVES/COLORIZATION BY BRETT BOATRIGHT, MARKETING TALENT NETWORK

*Does this 60-year-old image show hydrogen burning? A former NASA hydrogen fuel program manager, who had it colorized according to eyewitness statements, doesn't buy that long-standing theory.*

frame by frame. How could I have missed it? When the bow settles to Earth, it bounces. Minus their lifting gas, zeppelins could not withstand—let alone defy—gravity. Yet in the newsreels we see the Goodyear-manufactured gelatin-latex gas cells nobly resisting the terrible firestorm until, one by one, they melt open and gently lower the flaming bow down to earth. (Of course, some escaping hydrogen burned, but it would have been well above the passengers and the airship.) On the downward leg of the bounce, the last cell vanishes and the naked girders collapse.

Bain really had something here. It was high time the hydrogen community and the lighter-than-air community hugged and made up. I hastily wrote up a summary of our observations and sent it off to the Lighter-Than-Air Society newsletter.

At the society's next meeting, Bain presented a list of rare books he needed for research, and before long he had developed a list of specific questions about the LZ-129's construction. Our Historical Action Team was able to locate some details, but the exact chemical composition of the outer covering proved difficult to find. Just as he had promised us details of the ship's vent system, the knowledgeable Don Woodward, editor of *Aerostation*, succumbed to heart trouble. Then *Buoyant Flight* editor Eric Brothers returned my treatise covered in angry red ink notations pointing out flaws in the theory. Eric's complaints were numerous: What about the testimony of crewman Helmut Lau, stationed in the tail, who reported a glow from inside cell IV? And what about the anguished eyewitness recording radio reporter Herb Morrison was making of the event? The explosion was so great it supposedly knocked the needle off the record he was cutting. Even Hugo Eckener, the best known of the zeppelin captains and chairman of the company that had made the *Hindenburg*, blamed the disaster on a broken wire cutting one of the gas cells, which resulted in hydrogen escaping and mingling with air under the outer cover. Backing up that theory were eyewitness accounts of a Japanese lantern-like glow from inside the burning hull.

Leading zeppelin historian Douglas H. Robinson had been repeatedly quoted as saying, "The one indisputable fact in the disaster is that the *Hindenburg* burned because she was inflated with hydrogen." No one was going to give that idea up without a fight. But Bain explained to me that people who know hydrogen had long maintained that the LZ-129 accident did not look like, or act like, a hydrogen fire alone. In ordinary conditions, you can't even *see* burning hydrogen, let alone see it glowing through an airship's skin or

SCOTT ANDREWS

*One clue to the demise of the* Hindenburg *may be found in the bright, aluminum-based combustion that occurs with the ignition of the space shuttle's solid rocket boosters.*

creating brilliant colors. The high temperatures required to burn hydrogen would first melt the thin gas cells, and gravity would then reclaim the stalled *Queen Mary*-sized vehicle from its altitude immediately. Only a cartoon character like Wile E. Coyote is able to pause to consider he's stepped off a cliff. But it was in Tinseltown that we found a clue to what really happened.

Hollywood was a quick stop on the way to Edwards Air Force Base, where I'm occasionally sent to support a shuttle contingency landing. I stopped to visit with a friend at Image G, a special effects and model-making shop doing work for the "Star Trek: Deep Space Nine" and "Voyager" TV series. We were discussing the shimmering "transporter" effect—created by filming aluminum dust in bright orange light—when the flammability of aluminum came up. Someone mentioned that aluminum dust burns so brightly that special effects people toss it in burners to simulate lightning.

It was about then that Bain visited the National Archives and found crewman Helmut Lau's entire testimony. As he read it he realized Lau's description, which had contained some puzzling elements, was consistent with a huge aluminum fire. For example, although most witnesses on the ground were on the *Hindenburg*'s port side and reported seeing the fire start there, Lau, the first person to notice the fire, insisted it had started on the starboard side. Burning with the brightness of the shuttle booster rockets, an aluminum fire would easily show through the port side where the news cameras were. Lau also reported a glow coming from the forward bulkhead of cell IV. Since hydrogen makes no visible flame, it had to be the reflection of a bright fire. Add the cloth, dope, pigment, wood (strips and dowels at seams), gas cells, adhesives, ramie cord, and silk tapestry and you'd have a colorful—and horrific—bonfire.

Now the witness statements started making sense. Max Pruss, the captain of the doomed ship, insisted there was no indication of gas loss on the bridge, riggers reported all gas cells were evenly inflated, and no one reported smelling garlic, the scent of which had been added to the lifting gas to help detect a leak. An old book on fabric told us the ship's cover would ignite at less than half hydrogen's ignition temperature, making the slashed cell theory unworkable. Most important, to achieve the right air/gas ratio for a hydrogen fire, you'd need something on the order of the Star Trek transporter to get roughly 200,000 cubic feet of air to materialize in an opened gas cell.

So what *had* set the outer cover afire? Bain would first have to confirm its composition. Fortunately, Hepburn Walker Jr., a World War II airshipman, had some samples of LZ-129 fabric he'd recovered from the Lakehurst, New Jersey mooring site where the *Hindenburg* fell. Cheryl Ganz, editor of *The Zeppelin Collector*, also lent one swatch from each of the two *Graf Zeppelins*. The NASA Materials Science Laboratory at the Kennedy Space Center was busy investigating the failure of the Italian tethered satellite last spring when Bain approached with the fabric samples. Various types of detailed analysis would have to be performed to develop an exact list of components, but the lab techs and scientists volunteered to help on what became known as "Project H."

Bain went into high gear, interviewing experts at the Fire Sciences Laboratory in Missoula, Montana, airline pilots who have witnessed corona discharges—luminous discharges of electric energy—on the surfaces of their craft, and even, to rule out sabotage, the Virginia FBI National Center for Analysis and Violent Crime. He visited the former airship mooring sites in Lakehurst and Akron, Ohio, and talked to Harold Dick, a Goodyear/Zeppelin engineer who made many LZ-129 voyages. Finally, at the picturesque village of Friedrichshafen in Germany (where, ironically, the Zeppelin company is building the new hydrogen tank domes for the space shuttle), Bain talked with LZ-129 survivors. The Zeppelin company and the

Friedrichshafen Museum laid out the red carpet (see "Company Town," Feb./Mar. 1997). Bain returned with many treasures, including some handwritten letters concerning the covering. But this technical German needed careful translation, and 50 pages of NASA lab reports were now awaiting Bain's interpretation.

From this point on, I could only listen in awe, trying to get all this down in layman's terms. The lab reported that fabric from the LZ-130, an airship that had been under construction at the time of the *Hindenburg* fire, displayed spectrograph spikes of sulfur and calcium that were absent from the earlier airships. Why had the Germans added calcium sulfamate, a textile fireproofing agent, to the new ship when Hugo Eckener himself had blamed hydrogen?

Bain's theory was taking shape: Captain Pruss and company had just chosen the wrong night to accept the American suggestion to make a "high" landing. (The landing technique the more experienced Germans preferred was to drive the airships directly down to ground-level mooring masts. The Americans often moored their ships high, thinking that that kept them safer in gusting winds, and then gradually winched them down to earth.) Thunderstorms had come through Lakehurst that day, and when the *Hindenburg* made its high landing, lightning was still flickering on the horizon. If the *Graf Zeppelin*—or even our own USS *Akron* or *Macon*, which used nonflammable helium—had been in LZ-129's place that night, they would have wound up the same way. Once the bow landing lines were dropped, Mother Nature saw six and three-quarter acres of electrically retentive surface area kiting in a highly charged atmosphere.

One witness, a college professor named Mark Heald, had reported seeing a blue glow of electrical activity dancing along the ship's starboard topside for about a minute just before the ship caught fire. Although such plasma events are typically short-lived, airplane pilots have reported seeing some lasting up to 80 seconds. The blue light is indicative of the extremely high local temperatures a corona discharge can yield: in the neighborhood of 10,700 degrees Fahrenheit. And they produce the powerful oxidizer ozone, known enemy of aluminum.

So we had hot plasma hugging the retentive hull for nearly a minute, bathed in unstable ozone—itself reacting with the aluminum. Heald had seen the blue glow turn into licks of flame. From that point, the *Hindenburg*—and with it the romance of the passenger zeppelin—was doomed.

However, Bain's theory could be proven only by duplicating the heat of a corona discharge atop real LZ-129 material. Luckily, Bain had obtained two 60-year-old representative samples of fabric. But the fabric on the *Hindenburg* had been less than two years old when the fire broke out. Would his samples still be volatile after six decades? Last November investigators at the NASA lab placed one sample in a chamber for a flame propagation test. To their surprise, the fabric went up in seconds. Then, in January, lab workers blasted the remaining fabric sample in a device that produces high-voltage electrical fields, a test that more closely replicated conditions of that May 1937 evening. A thread-like electric arc burned a hole in the fabric, duplicating reports of zeppelins having been struck by lightning and suffering only localized damage. But when the sample was mounted so it remained parallel to the arc, the electrical energy ignited the fabric and it disappeared in seconds.

Yet as it turned out, Bain and his team had not needed to go to all this trouble. When the handwritten German letters were finally translated, we saw electrical engineer Otto Beyersdorff matter-of-factly writing on June 28, 1937: "The actual cause of the fire was the extreme easy flammability of the covering material brought about by discharges of an electrostatic nature...." Elsewhere he says: "the reported details about the fire made the causes of the origination so definitely clear—namely, the ignition of the covering caused by electrostatic discharge—I found it necessary to report as follows: The 'Werks' was kind enough to send me a sample of the covering material; with which I was able to perform tests in the laboratory matching the conditions of the accident and which proved the material to be extremely easy to inflame. An acquaintance of mine, an academic advisor, who took part in some of the tests, was amazed at the high degree of flammability."

So they had known it all along. And now, thanks to Addison Bain, we do too. My hunch is that zeppelin supporters like Hugo Eckener had assumed that blaming the gas—which he had hoped to replace with helium—would do less damage to the zeppelin industry than faulting construction of the zeppelin itself.

Never again can aeronautics' most photographed disaster be blamed on nature's simplest element. Who knows, maybe I can finally convince my fellow "helium heads" that hydrogen would be the ultimate airship engine fuel.

*—Richard G. Van Treuren*

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THE LATEST WORD ON TOURS AND LEARNING ADVENTURES

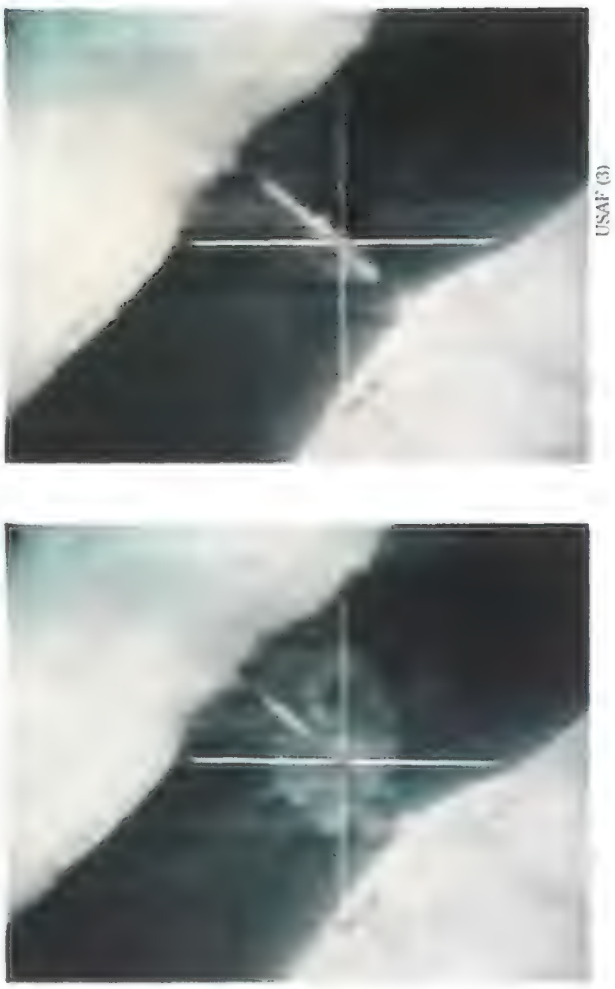
# THE INVISIBLE MEN

In October 1973, during the "Yom Kippur war" when Egypt and Syria attacked Israel, a Lockheed SR-71 Blackbird made an epic 15,000-mile, 10.5-hour nonstop flight from the United States to Israel and back. When the feat was revealed to the public months later, it only enhanced the mystique of the world's fastest, highest-flying, and spookiest spyplane. Even then, few people knew that the SR-71 was the third member of the Blackbird family, which had started with the Central Intelligence Agency's A-12. Nor did people realize that the Blackbird's shape and structure were designed to reduce its radar signature.

It's been said that the Blackbird's radar image is roughly equal to that of a standing human figure; a non-stealthy fighter, even one smaller than the SR-71, has the radar cross-section of a van. Soviet radars could still detect the Blackbird once it came within 100 miles, but it flew so fast and so high that any missile engagement would turn into a tail-on shot, and the missile would run out of energy.

The CIA had wanted an airplane that would be as close to invisible as possible, but at the time, nobody could see a way around the mathematics of the radar range equation, which stated that detection range varied with the fourth root of the radar cross-section (RCS)—the measure of an object's reflectivity. Even if an airplane could be designed with half the RCS of the Blackbird—which seemed unlikely in a discipline where a 10 percent improvement in any number is a triumph—the result would be an uninspiring one-sixth reduction in detection range. When you did the math, the numbers implied that it would be impossible to build an aircraft that would survive by stealth alone without the benefit of the Blackbird's speed and altitude performance.

Working in the U.S. Air Force's Radar Test Building, an all-wood structure on the fringe of the Wright-Patterson Air Force Base in Dayton, Ohio, Bill Bahret had come to be regarded as "the father of radar camouflage" for his pioneering work on radar signatures—the characteristic patterns of reflected radar—in the 1950s. Allen Atkins, then a civilian Air Force mathematician at Wright-Patterson, recalls that Bahret "had driven a stake into the ground. He had said that for a given size and volume, you'd never get below a certain level of RCS." An airplane's size and weight seemed to set a lower limit to its RCS. At the time, even if a very low RCS could be achieved, there was no way to confirm that it had been done. None of the RCS test ranges—they look like runways with radars at one end and a pylon or "pole" at the other to mount a model—was sensitive enough to measure a target with very low RCS.



USAF (3)

*Stealthy aircraft that return very little radar signal, such as the Lockheed Martin F-117A (left), when combined with precision weapons like the one taking out this Iraqi bridge, can alter the balance in a conflict.*

The term "stealth" was not widely used, though it had been coined in the context of manned aircraft as far back as 1966 by Charles E. "Chuck" Myers, a combat pilot and later a Lockheed executive. An advocate of making fighters smaller and lighter, Myers cited stealth as one advantage of small size, but he did not link it explicitly to low-RCS design. Smaller fighters were also simply harder to see at a distance.

Atkins recalls the genesis of today's stealth technology in the late summer of 1974 this way: The Air Force had used remotely piloted vehicles (RPVs) in Vietnam and was looking at much smaller, less complex versions to take their place. The RPVs were small and had proven difficult to see on radar. Meanwhile, the Pentagon's scientific consulting group, the Defense Science Board, had completed one of its annual studies for the Air Force; these periodic reports, usually secret, were conducted on the orders of Air Force leaders on topics of interest to them. Reviewing the air battles over Vietnam and the Middle East, the board concluded that U.S. aircraft would soon "have a real challenge getting through air defenses," Atkins recalls.

He was working with a group at Wright-Patterson that supported the Defense Advanced Research Projects Agency (DARPA). It was in late 1974, Atkins says, that the Pentagon's deputy director for research and engineering, Malcolm Currie, asked the group if it would be possible to build a manned aircraft with a signature as low as one of the least detectable RPVs. "We said we'd give it a try," says Atkins.

DARPA briefed the major U.S. manufacturers of fighters and other military aircraft on the study, which was code-named Harvey, a reference to the invisible rabbit that accompanied Jimmy Stewart in the movie of the same name. Small design contracts were awarded to McDonnell Douglas and Northrop in early 1975. "For some rea-

## Electrical engineers ruled. Aerodynamicists coped. When they invented stealth, they forever changed the way combat aircraft are designed.

by Bill Sweetman

son," Atkins recalls, "the DARPA office touched base with only one division at Lockheed, and they didn't indicate that they wanted to bid." Nobody asked Lockheed's Advanced Development Projects division—the Skunk Works.

John Cashen joined Northrop's Aircraft Division two months after DARPA's first query arrived. Cashen had been a scientist at Hughes and had come to Northrop in 1973 to work on lasers. The project ended after a year, and late 1974 found Cashen in a holding pattern, circulating his résumé back at Hughes. When Cashen saw the first Harvey memo, "I realized that this was what I had been training for all my life," he recalls. "I was in the right place at the right time." A forceful personality, Cashen became the leader and spokesman for the more junior electromagnetics experts on the team. The group was joined by Irv Waaland, a hands-on designer who had come to Northrop from Grumman barely a year earlier.

RICK LLINARES/CHECK SIX

*The F-117A Nighthawk's odd shape comes from the murky world of electronics, not aerodynamics.*

It has been said that Northrop's approach to stealth relied on computer technology, but Cashen tells a different story. "If we'd had a computer [that could predict RCS] we'd have used it," he says. "We were not able to synthesize RCS. We couldn't get a complete answer. It was better to use experience [such as work on radomes and reentry vehicles] and the tools that we had, and do it experimentally. We ended up using a shaping solution that, in general, ended up working when we tested it." Based on tests performed on models, Northrop developed some rudimentary empirical rules for shaping—more like a handbook than a formula or program—that yielded good results.

Harvey was not highly classified, so it was not surprising that it eventually came to the attention of Ben Rich, who took over control of Lockheed's Skunk Works in January 1975. By the time Rich heard of it, DARPA had spent all of the project funds, so the Skunk Works volunteered to perform the work for no fee. Rich asked Warren Gilmour, the Skunk Works' head of operational research, to put together a Harvey team. Gilmour called Denys Overholser, who was laid up at home after making an ill-advised use of his leg as a toboggan brake. Overholser was younger than many of the Skunk Works designers; unlike others, including Harvey program manager Dick Scherrer, he had joined the Skunk Works after the incredibly difficult Blackbird program. Overholser was also an electrical engineer and mathematician who specialized in radomes and antennas in a business where aerodynamicists ruled the roost.

In Rich's book *Skunk Works,* he tells how Overholser discovered the "Rosetta Stone" to stealth technology deep within a long, impenetrable technical paper. Pyotr Ufimtsev, a Russian expert in theoretical optics, offered clues that showed how to calculate the RCS of parts of an airplane, then add them together and get the right answer.

His leg mended, Overholser returned to work in May. "I went to see Dick Scherrer and told him how to make an airplane invisible," he recalls. The computer program would come later. "You needed the mathematics, but you need to have a feeling for the solution as well," Overholser points out. "A flat panel is the brightest target, and also the dimmest." If the panel is at right angles to the incoming beam, it is a perfectly reflecting target. Rotate it along one axis and most of the energy is deflected away from the radar. Rotate it along two axes and the RCS becomes infinitesimal. So, reasoned Overholser, make an airplane entirely out of flat panels, each angled so that none is ever likely to be facing straight toward a radar. Ufimtsev's diffraction theories helped predict the scattering from the edge joints between panels.

Lockheed built a model of the strange diamond-shaped airplane that resulted from applying Overholser's principles. Aerodynamicist Dick Cantrell dubbed it the "Hopeless Diamond." Despite the pessimistic nickname, the model's RCS was incredibly small—too small to be measured at Lockheed's facilities. "They decided that I wasn't the village idiot, so I became a genius instead," Overholser says.

Northrop's team had designed a diamond shape with a pyramidal body mounting air inlets above and behind the cockpit. McDonnell Douglas was no longer in the race. "Lockheed and Northrop were very aggressive," Atkins recalls. "They threw the paradigm away and looked at the problem in a different manner." During the summer of 1975, Ken Perko of DARPA and Bill Elsener of the Air Force worked on a plan to fly one of the aircraft. So in September the two companies were asked to design a small prototype aircraft and build a full-scale model for a "pole-off" at the RCS range at Holloman Air Force Base in New Mexico, with the winner going on to flight test. By now, the project's name had changed to the more respectable Experimental Survivable Testbed, or XST.

Both teams joined forces to upgrade Holloman's RCS range so that it would be able to measure the very low reflectivities of the new designs. The competition was fierce. "We were all working 12 to 16 hours a day, seven days a week," says Waaland. At the range, the teams shared a hangar and were separated by only a black curtain. "We weren't supposed to peek, but it wouldn't have mattered," Waaland says. There was

no time for major design changes.

Waaland knew that Northrop had a problem. Northrop's analysts had concluded that it was most important to reduce its vehicle's RCS from the nose and tail and that the nose-on RCS—the view an adversary had in the critical head-on engagement—was more important than the rear aspect. Its XST design was a diamond with more sweep on the leading edges than the trailing edges. From the rear, it had low RCS as long as the radar was no more than 35 degrees off the tail.

But the DARPA requirement treated RCS by quadrants: The rear quadrant extended to 45 degrees on either side of the tail, thereby including the parts of the airframe where the Northrop design's RCS spiked. Waaland could not solve the problem by increasing the sweep angle of the trailing edges, because at very high sweep angles, the aircraft would become uncontrollable.

And Northrop had an internal issue to deal with. "The level of security on the observables was higher than it was on the airplane," says Waaland, "and not too many of the airplane people were cleared into the [details of the low-RCS design theory]. It was a great source of frustration, because there was no ability to make compromises." This put Northrop at a disadvantage, because the program was all about compromise: to minimize RCS while attempting to preserve acceptable aerodynamics. The normally reserved Waaland recalls epic shouting matches in which he would question Cashen about some aspect of the mysterious electromagnetics. "You know just enough to be dangerous," was Cashen's usual retort.

Over at Lockheed, they were inventing on a schedule. Before the proposal went in, Overholser and his mentor, Bill Schroeder, took five weeks to write a computer program called Echo that provided a first-cut check on the design's RCS. They worked independently, cross-checking results to avoid errors.

In August 1975, Alan Brown joined the Lockheed stealth team. Born and trained in the United Kingdom, Brown was a newcomer to the Skunk Works. "We were surprisingly fortunate on the XST," Brown says today. "It went better than we deserved." Lockheed had designed a notched trailing edge for its XST to replace its original Hopeless Diamond shape. This allowed the team to sharpen the sweep angles on the rear of the aircraft and meet the DARPA rear-quadrant requirement.

Overholser's design philosophy forbade curves, even in the airfoil, because their reflectivity could not be modeled or predicted. The XST's airfoil section, which was a series of six straight lines rather than a smooth curved surface, appalled aerodynamicists because it seemed clear that airflow over the wing would separate at its first meeting with the junction of two flat surfaces, creating turbulent flow and drag (see "Go With the Flow," June/July 1995).

*A chamber with radar-absorbing walls enables designers to test shapes on models before finalizing designs.*

LOCKHEED MARTIN SKUNK WORKS

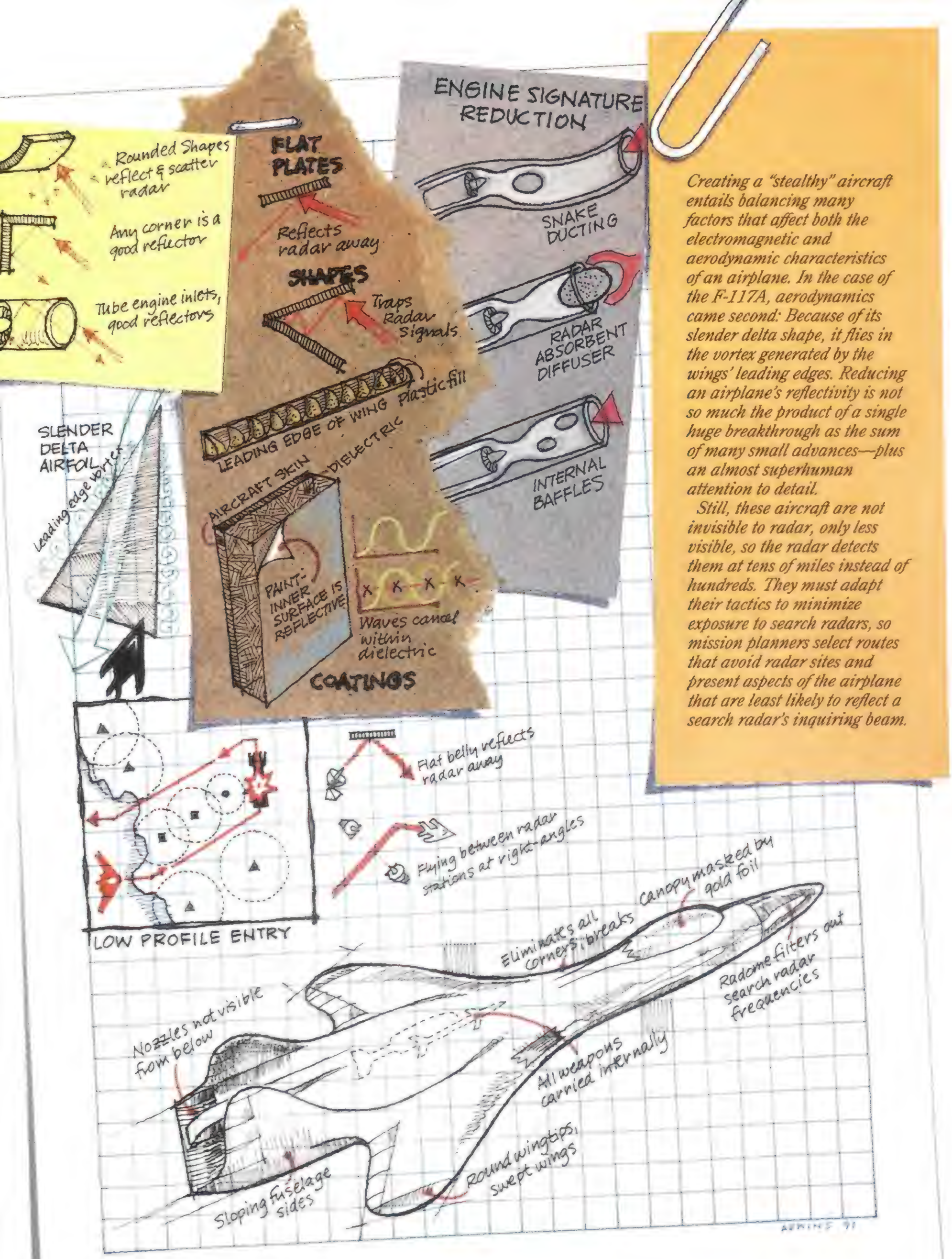
DENNY LOMBARD/LOCKHEED MARTIN (2)

*Denys Overholser (left) and Alan Brown helped take the Skunk Works from "not invited" to "winner" in record time. Lockheed software predicted the reflectivity of faceted shapes, which were then tested in assembled form on "the pole" (below).*

But Brown had worked on Lockheed's supersonic transport design and knew that a delta wing as sharply swept as the XST's (the F-117A's sweep is 67.5 degrees!), with a sharp leading edge, "really flies on the vortex generated from the leading edge, and conventional two-dimensional aerodynamics don't apply at all." Inside one of Lockheed's hangars, engineers test-flew XST models from the fourth-floor mezzanine.

The Skunk Works' ace in the hole was the plastic radar-absorbent material (RAM) it had used on the A-12 and SR-71. Unaware of Lockheed's work, Cashen did not place much reliance on such materials. "I realized that nobody was making what I needed," he says. "I was using commercial RAM, and it was trash." The commercial type of RAM, used in bulk form to prevent undesirable echoes around antennas, was more like a building material—heavy and fragile—and completely unsuitable for aircraft. Then Cashen attended a secret symposium at Wright-Patterson in 1975, where Skunk Works founder Kelly Johnson described the SR-71's stealth features. "Nobody had figured out that the SR had stealth," Cashen recalls. "I sat there with my mouth open." Lockheed's XST would be covered with RAM.

LOCKHEED MARTIN




*Creating a "stealthy" aircraft entails balancing many factors that affect both the electromagnetic and aerodynamic characteristics of an airplane. In the case of the F-117A, aerodynamics came second: Because of its slender delta shape, it flies in the vortex generated by the wings' leading edges. Reducing an airplane's reflectivity is not so much the product of a single huge breakthrough as the sum of many small advances—plus an almost superhuman attention to detail.*

*Still, these aircraft are not invisible to radar, only less visible, so the radar detects them at tens of miles instead of hundreds. They must adapt their tactics to minimize exposure to search radars, so mission planners select routes that avoid radar sites and present aspects of the airplane that are least likely to reflect a search radar's inquiring beam.*

ILLUSTRATION BY JAN ADKINS

NORTHROP GRUMMAN (2)

*Designed for a nuclear mission (finding and destroying mobile Soviet missiles), the B-2 Spirit brings long range and endurance to the conventional mission as well. Northrop Grumman will build 21 B-2s (below).*

In March 1976, the leaders of the two teams went to the Pentagon to present their test results and their prototype proposals. Perko and Elsener listened to each team and made their decision on the spot, but it was not to be announced until the next day. Ken Perko invited the competitors to spend the evening at his house in Virginia's horse country. As Irv Waaland recalls, "You could cut the air with a knife."

Waaland and Cashen were relatively unknown compared to Kelly Johnson and Ben Rich. Already, says Waaland, "We felt that we weren't going to win." The decision was announced the next day. Northrop's airplane was expected to fly better, but Lockheed's was stealthier, and that was the point of the exercise. Lockheed was awarded a contract to build two XST prototypes.

"I ended up with shingles," says Waaland. "Most of us were completely exhausted." Cashen, as always, was the contrarian. "I saw grown men cry when we lost," he remembers, "but I said 'Good. Good for America.' We'd done a good job, but I had an immature RAM capability. I could prove on the pole that I was as good as they were. They had won by a whisker, and if the rules had been different it might have gone differently. But they could turn their design into a real airplane and I had a long way to go."

By now a change had crept into the program. Alan Brown traces it to the first Lockheed and Northrop tests at McDonnell-Douglas' Gray Butte RCS range in California's Mojave Desert in the fall of 1975. The RCS numbers were not merely half those of a conventional aircraft, but a hundred or a thousand times smaller, enough to render most radars useless.

"People realized that we had a tiger by the tail," says Brown.

The XST project was upgraded to top secret, and when Lockheed won the contract, it became an unacknowledged Special Access program. Only those with a need to know would be told that the project existed. The designation XST was replaced by the code name Have Blue, and the project office moved from Washington to a secure "vault" at Wright-Patterson. The airplane would fly from Area 51, the secret flight-test base at the edge of Groom Lake, Nevada. Built for the U-2 and expanded for the A-12 program, Area 51 was home to a secret squadron of Soviet-built aircraft and officially, it did not even exist. The program included four full-time people and six part-timers at Wright-Patterson, and three or four people at DARPA. Outside that circle, recalls Atkins, only the Secretary of the Air Force, the three-star general in charge of Air Force research and development, and one or two other generals knew about Have Blue.

Insiders believe that the secrecy was very important. As Alan Brown observes, "The purpose of secrecy is not just to protect information but also to deny an adversary the knowledge that a problem has been solved." In the 1970s, he explains, "Most people thought that RCS reduction was not worth doing because of the fourth-root problem. Nobody's going to put resources into a

problem that can't be solved within a generation." He believes that had the United States indicated the levels of RCS that were being achieved, other countries would have pushed stealth much harder.

Paul Kaminski, a Pentagon scientist who joined the stealth effort in early 1977, says that secrecy stopped "the foreign body rejection" problem. "One advantage of secrecy," he adds, "is that it prevents the liability of leadership. In a commercial business you rarely find a leader introducing a radical new product. Why take the risk of upsetting the situation? With secrecy, the barriers are down and a new idea can mature." It was not until 1980 that Kaminski decided that the isolation was not entirely a good thing. "I took one percent of our resources and invested it in counterstealth," he says. The money funded a "Red Team" with the authority and resources to look critically at every aspect of stealth. The team was divided in two: One group worked with full knowledge of stealth; the other worked from public sources. The effort taught some important lessons. "One element of the operational community had bought into the idea that it was an invisible airplane that could fly with complete immunity," says Kaminski. "That was not accurate." In these early years, the Red Team studies underscored the importance of using tactics and route planning so that an aircraft would show its least visible side to radars.

The DARPA-Air Force management team worked on the edge of Pentagon rules, using secrecy as a justification for avoiding onerous reporting as well as the regulations governing competition. The government managers were keen to maintain a second source of stealth technology but did not want to compromise the secret of stealth by holding another open competition. In December 1976, Bruce James of DARPA asked Cashen to come to Washington to talk about an agency project to stop a Soviet tank attack with a hail of precision-guided weapons. It depended on an airborne radar carried on a stealth aircraft called BSAX (Battlefield Surveillance Aircraft—Experimental). DARPA planned to award it to Northrop as a sole-source contract.

But BSAX was more difficult than Have Blue. Says Waaland, "We didn't know how to put a radar in a vehicle, turn it on, and remain stealthy." BSAX would have to loiter over the battlefield for hours, and it would be illuminated by many radars from different directions. Unlike Have Blue, BSAX would have to be an "all-aspect stealth" design. As Northrop started to design BSAX and Lockheed continued cutting metal for the two Have Blue prototypes, the administration of President Gerald Ford packed its bags and departed.

The Carter administration's new Secretary of Defense, Harold Brown, assigned responsibility for stealth to his deputy secretary of defense for research and engineering (and later, Secretary of Defense under President Clinton), William Perry.

One of Perry's first actions on stealth was to appoint Paul Kaminski "to serve as his technical conscience," as Kaminski puts it—to learn "Was it real or not?"

Kaminski's report was positive. The next step was more difficult. Assuming that Have Blue worked, how should stealth be used? In the spring of 1977, Perry convened top Air Force officials to study the question, with the help of a small team. (One of two majors on the team was Joseph Ralston, now a

*A blend of lines and curves, the B-2 recalls the original Northrop YB-49 Flying Wing but did not evolve from it.*

EDCARLSON/CHECKSIX

NORTHROP GRUMMAN (3)

*Northrop's John Cashen (left) and Irving Waaland battled over compromises in their design for the XST, only to lose in the end. But the loss led indirectly to the BSAX program and to the B-2.*

general and the vice chairman of the Joint Chiefs of Staff.) The group seriously considered whether the potential of stealth was so explosive that the technology should be shut down, the programs stopped, and the data locked away. The Soviet Union seemed to take less time to develop new generations of weapons than the United States did, and to field them more quickly once developed. Stealth did not discriminate between U.S. and Soviet radars. But Perry, Kaminski recalls, "thought it was better to run fast than to behave like an ostrich." Next, the Pentagon group examined what kind of stealth combat aircraft could be developed using Have Blue technology.

Lockheed's studies showed that size and weight would rise out of sight if the designers aimed at much more than a 600-mile combat radius with 5,000 pounds of bombs, but in the Air Force enthusiasts wanted a larger, two-seat aircraft, as big as the 45-ton FB-111 bomber. "We had much less confidence that we could pull that design off," says Ralston.

During 1977, the Air Force decided to focus on the smaller airplane first, and Lockheed started work on what would become the F-117. The larger airplane served as the starting point for a nuclear bomber, which evolved into the B-2. These decisions had little immediate impact on Northrop, which was preoccupied with the BSAX. Northrop put its first models on the pole in the summer of 1977.

"It was a disaster," says Waaland, who was summoned to rescue the program. DARPA's Ken Perko, worried that Northrop might not be able to make BSAX work, quietly invited Lockheed to study the concept. Fred Oshira, one of Cashen's electromagneticists, saved Northrop's face. "I don't want it to come out this way," muses Cashen, "but Fred could see the waves on the surface of the airplane. He had so much experience in electromagnetics." With the BSAX problems constantly on his mind, Oshira had taken to carrying a piece of modeling clay with him—even when he took his family to Disneyland. Sitting on a bench and watching his children on the teacup ride, Oshira molded the clay into a new shape, with a rounded top and flat sloped sides that flared down and outward into a knife-edge. It worked, flowing the radar energy around the body rather than scattering it like a mirror. Northrop had discovered not only a way to remain stealthy from any direction, but a way to defeat a wider range of radar frequencies.

*Call it the BSAX, Tacit Blue, or the Whale, the Battlefield Surveillance Aircraft is a plain plane.*

Again, better computers helped, "but we didn't design the aircraft on the computer," says Waaland. "Computers allowed us to look at parts of the aircraft in two dimensions. We could blend them together, but we didn't have an integrated model." With the major RCS problem solved, the BSAX design came together in the second half of 1977. "The hardest job," says Cashen, "was getting the goddamn radar in there." The BSAX matured into an awkward-looking airplane designed rather like a Huey helicopter, around a huge box with open sides. It had a bluff nose and a bulky body to accommodate the radar. The engines were buried at the rear behind a flush dorsal inlet. An observer on the ground would see no sign of an engine at all. Worried about how the ends of the angled tail would appear on radar, the designers curved the tips of the V-tails toward the horizon. It added an organic touch to an already strange design, which soon acquired the nickname "Whale."

The commitment of the Whalers, as the BSAX team called themselves, was such that people had to be escorted out of the building and sent home late at night so that they would not run themselves into the ground. "I was in love with that project—the people who built it and that bloody airplane," says Cashen. (see "Out of the Blue," Soundings, Aug./Sept. 1996.)

At the end of the year, Perko dropped a bomb on Northrop, announcing that

he was planning a BSAX pole-off with Lockheed. Company president Tom Jones told Perko that Northrop would not compete. As Waaland relates it: "Did DARPA really want a competition? Could they stand the answer if Northrop lost and they created a stealth monopoly?" Northrop got the contract to build and fly a single prototype of BSAX, now code-named Tacit Blue.

Lockheed's first Have Blue flew in December 1977. On its 37th flight, on May 4, 1978, its landing gear was damaged, forcing test pilot Bill Park to bail out. Park was injured in the ejection, and the prototype descended unmanned to the desert floor in a falling-leaf maneuver. It was intact but could not be repaired. In the name of security, a construction team dug a pit in the desert at Area 51, where the historic airplane is still buried. Alan Brown is not sure that anyone kept an accurate record of the site. "I think they built a road across it," he says.

By this time, such extraordinary secrecy measures had become routine. Steve Smith was working for Northrop in Iran in January 1978 when Northrop's engineering chief, Welko Gasich, arrived to tell him that he was needed in the States. Smith would have to fly home to find out what he was working on, and once he was briefed he would not be able to return. Leaving his wife and children to finish the school year in Tehran, Smith flew back home. It was five years before he worked on a program he could discuss with his family. There were no non-secure phones that could be used for calls outside, and families had only a phone number that could be used to send an emergency message to the base. Compliance with the ban on mentioning the vaguest details of work was closely monitored. Agents would strike up conversations in beauty salons to test the engineers' wives and watch for signs of loose lips. One engineer's children told classmates that their father worked for the CIA, because nothing else seemed to fit.

After Tacit Blue was declassified, Steve Smith's wife Margaret called their daughter, also an aerospace engineer, and told her that it was finally possible to talk about what Smith had been doing for those five strange years. "I know about that," she said. "I worked on that program too."

Lockheed's F-117 made its first flight in June 1981, on schedule. Over several years it evolved into an accurate, reliable bomber. With powerful lobbying from Ben Rich and others at Lockheed, Congress increased production from the planned 20 aircraft to 59.

The Whale flew in February 1982. Its stealth technology enabled Northrop eventually to beat Lockheed to win the defense contract of the century—the B-2 Advanced Technology Bomber. When the Pentagon decided to develop a different battlefield surveillance radar and canceled Tacit Blue in 1985, the program had been operating in secret for 11 years.

In a footnote to *Skunk Works*, Ben Rich noted that Pyotr Ufimtsev moved to California and learned of his role after 1990. His former Soviet colleagues had been "uninterested," he said.

Mostly retired now, the people who created Have Blue and Tacit Blue remain close, even with their former rivals. They are quicker to grant credit than to claim it. Their bonds were forged in months and years of intense collaboration and competition, of working long stretches under rigorous secrecy. Since 1992 they have met regularly in Dayton, Ohio, where the stealth projects were managed. Still wary of talking in public, even about the events of the 1970s, they wear a discreet pin in the shape of the original Hopeless Diamond, a shape that will be echoed, to some extent, in all the military aircraft of the early 21st century.

*The YF-22, with its numerous trapezoidal surfaces, echoes the original Hopeless Diamond, though it is generations ahead of its progenitor.*

DENNY LOMBARD/LOCKHEED MARTIN

# Collision Course

After the 1949 air races were marred by tragedy, few thought spectacle and safety could share a cockpit.

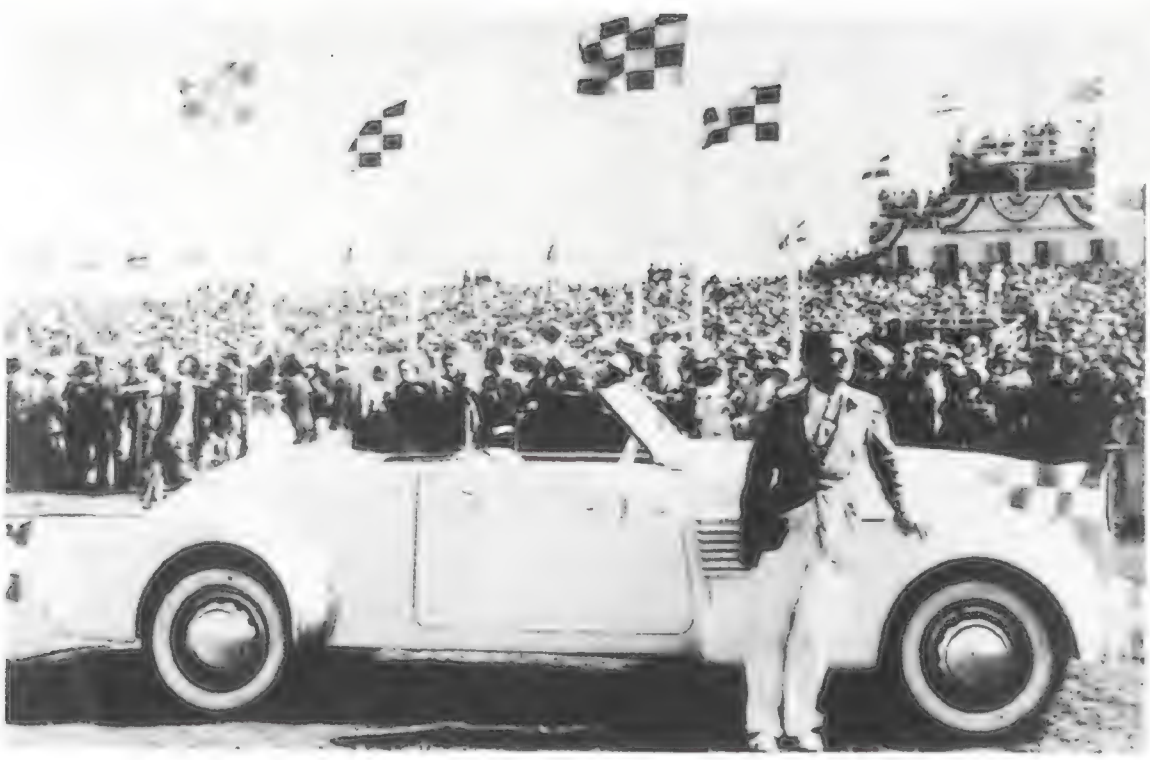
CAROLINE SHEEN

by Dominick A. Pisano

In the late afternoon of September 5, 1949, Bill Odom climbed into his highly modified North American P-51 Mustang *Beguine* to compete for the $40,000 prize in the Thompson Trophy Race at the National Air Races in Cleveland, Ohio. *Beguine*, owned by Jacqueline Cochran and modified by millionaire Texas oilman J.D. Reed, was at the time possibly the fastest piston-engine aircraft in the world. As such it heralded the beginning of a new era in big-plane racing that would revive competition among pilots and engineers.

Odom, an American who had been a pilot for the Royal Air Force Ferry Command in World War II, was an experienced long-

***In the wide open desert around Reno, Nevada, today's air racing courses see the same hard flying that carried a First Pursuit Group pilot around the home pylon in the 1929 John M. Mitchell Trophy Race (inset). With each race, pilots fly the line between caution and glory.***



ALL BLACK-AND-WHITE PHOTOS FROM NASM

*During its golden age, air racing was a heady mix of swashbuckling pilots, speed, spectacle, and Art Deco glamour (above and opposite, left). But racing died out because of several factors, including Bill Odom's 1949 crash of a P-51 into a house in Berea, Ohio (below right), dwindling corporate interest, and the Korean war. When it was reborn at Reno in 1964, the thrills and the World War II fighters were back (below), but the unique circumstances that made golden age air racing a premier sporting event were gone.*

RICHARD VANDER MEULEN (6)

distance flier. He had twice flown around the world, once in April 1947 and again that August, in a modified Douglas A-26 and had broken Howard Hughes' previous round-the-world record, set in 1938. Only two days before, Odom had flown *Beguine* to victory in the National Air Races Sohio Trophy event, but as a closed-circuit race pilot he was completely untested. Whether he could master the demanding Thompson Trophy course, which was marked by seven pylons placed in the suburbs surrounding Cleveland Municipal Airport, was still a question.

The answer came soon. Early in the race, Odom passed the second pylon too wide. He hastily tried to turn back into it but overcompensated, causing the aircraft to roll and go into a low-altitude inverted dive. The *Beguine* slammed into a house in Berea, Ohio, killing Odom and a young mother, Jeanne Laird, and critically injuring Laird's thirteen-month-old son Craig, who died three hours later. The airplane hit the ground so hard it lodged five feet deep. Odom's body had to be dug out of the wreckage.

Reaction to the crash was swift. The leading industry publication, *Aviation Week,* called it "Dangerous Exhibitionism" and editorialized: "The National Air Races no longer serve any useful purpose in these days of remarkable research and laboratory facilities. Some such tragedy as this was overdue. It was inevitable. The miracle is that the death toll was not larger."

Other aviation periodicals defended the races. One editorial denied that there was any connection between public acceptance of the airplane and the dangers of air racing. It pointed out that the public's confidence in the automobile wasn't shaken by the occasional crash or spectator fatality at the Indianapolis 500.

The controversy that accompanied Odom's crash is almost unimaginable today. Air race enthusiasts squint into the sun as World War II fighters scream overhead at the Reno air races, machines and pilots straining to their limits. Later, these same fans might doze off in an airliner after thumbing through a magazine and nibbling peanuts at 35,000 feet. For us, the division between the competition of air racing and the commerce of air travel is perfectly clear. But in the formative years of aviation, those

THE WESTERN RESERVE HISTORICAL SOCIETY, CLEVELAND, OHIO


COLOR PROGRAMS FROM NASM

who sought to promote its reliability and those who embraced it for the sheer thrill of flying struggled for its soul.

The conflict had a long history, beginning with 19th century aeronauts, who thrilled crowds by flying, and sometimes jumping from, balloons. A few years before World War I, both the Wright brothers and Glenn Curtiss formed enormously popular exhibition teams that tried to outdo each other in competing for the public's attention. But by the middle of 1912, five of the nine pilots who had served on the Wright Exhibition Team had died in crashes. Many characterized aviation as overpublicized, impractical, and frivolous. Such critics predicted that one day "circus stunts" would end, practical use of aviation would be commonplace, and the airplane would "come into its own," as one magazine put it.

After Word War I, those who thought aviation had commercial potential tried to reform its image. The Aero Club of America, one of the nation's first professional organizations devoted to flying, changed its name—to the National Aeronautic Association—and its focus. The leading force behind the 1922 transformation was Howard Coffin, a Hudson Motor Car Company executive. Coffin understood that if aviation were to become a profitable business venture, it had to have government regulation. Regulation would help insurance companies calculate risk and thus make it possible for them to underwrite aviation ventures.

Coffin turned to William P. MacCracken Jr., an associate who had presided over the drafting of the NAA charter. MacCracken, a former pilot and attorney who was an expert in aviation law, helped formulate the Air Commerce Act, the single most influential legislation in the history of aviation, which was signed into law by President Calvin Coolidge on May 20, 1926.

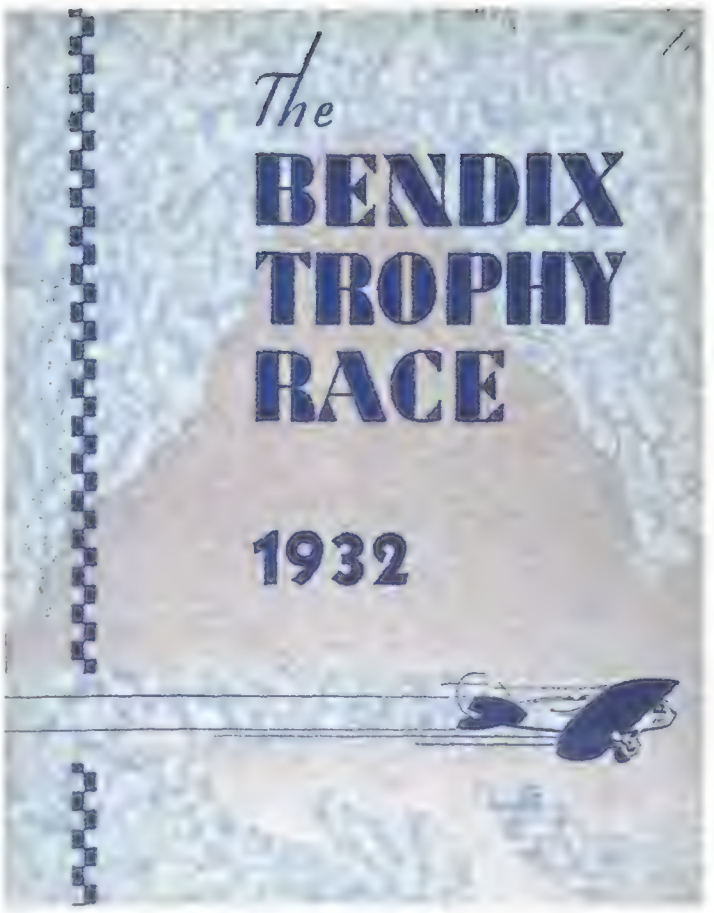
The act gave the Department of Commerce responsibility for licensing aircraft and pilots, providing civil airways and aids to air navigation, and regulating commercial and private aircraft operations in the interest of safety. It also provided for increasing public confidence in flying and promoting civil aviation. MacCracken was named assistant secretary of commerce for aeronautics, charged with carrying out the provisions of the new law.

MacCracken set out to change aviation's reckless image. As he said, "The time had

***Military aircraft, like the Boeing F2Bs shown above giving a demonstration during the 1928 National Air Races, began to dominate racing in the late 1930s. After World War II, custom-built racers had all but disappeared in favor of surplus fighters and trainers, including P-51 Mustangs, F8F Bearcats, and AT-6 and SNJ trainers (below).***

come for a new kind of aviation to emerge in this country, perhaps less colorful but certainly more responsible." His first targets were barnstormers, itinerant performers of daredevil aerobatics and stunts who brought flying to small towns across the country. By the early 1930s, the aeronautics branch had regulated them almost out of existence.

But the National Air Races brought a new era of showmanship. This event, reinvigorated in 1929 by Clifford W. Henderson and his brother Philip, became the premier aircraft competition spectacle. Henderson focused on three events: the Bendix Trophy Race, a transcontinental speed dash; the Greve Trophy Race, a closed-course event for aircraft with engine displacements of less than 550 cubic inches; and the Thompson Trophy Race, an unlimited-class closed-course race around a series of pylons. By the late 1930s, the National Air Races, held over the Labor Day weekend, were drawing more than 350,000 spectators.


The races were sanctioned by the National Aeronautic Association, but the young aviation industry, as represented by the trade magazines, opposed them. *Aviation* magazine, for example, published a 1937 editorial clearly articulating its position against the National Air Races: "We've never been particularly impressed...by the claim [made by Henderson, among others] that air racing, national or otherwise, makes a great scientific contribution toward the advancement of the art of flying. Talk of 'improving the breed' and 'the great laboratory of the industry,' and glib comparisons with the Kentucky Derby and the Indianapolis Classic seem to us to be the most specious form of twaddle." Despite the

*The National Air Races (far left and bottom) didn't have a permanent home until promoter Cliff Henderson landed the yearly competition in Cleveland in 1931. Henderson persuaded industrialist Vincent Bendix to sponsor the*

*transcontinental Bendix Trophy Race, which was held yearly until 1949 except during World War II. Bendix race pilots included Jimmy Doolittle and Jackie Cochran. All-jet Bendix races flown by military aircraft started in 1946 with two P-80s and ended in 1962 when a B-58 Hustler flew from Los Angeles to New York in 2 hours, 56 minutes with an average speed of more than 1,200 mph. Today's Reno pylon racers (above) carry on the tradition of the Thompson Trophy race, last flown in 1949, the year of the Odom crash.*

*John Livingston rounds a pylon in his clipped-wing monocoupe at the 1931 National Air Races (left). As air racing grew in popularity in the 1930s, an alarming number of pilots died in crashes. An aviation periodical of the time called for the Department of Commerce to "draft new licensing regulations that will ensure these high speed races shall serve to advance the science of aviation and shall not be degraded into a Roman holiday for the sadistic entertainment of morons." Today's racers are increasingly regulated to improve the safety of pilots and spectators alike (below).*


controversy over air racing's contribution to flying, the public continued to turn out for the event in record numbers.

Although the Nationals were halted by World War II and the Henderson brothers had retired, in 1946 the races were revived. The classic era of air racing, however, had passed. By the late 1930s, the winners were consistently military aircraft modified for racing, not machines designed and built expressly to perform in strenuous racing conditions. Most significantly, spectatorship fell off in the postwar period, and even the introduction of a new Thompson Trophy Race for jet aircraft failed to stimulate much interest. Even before the Odom crash, Cleveland, which had been the home of the National Air Races for most of the 1930s, had contemplated abandoning the event.

But the Odom accident changed air racing in the United States forever. Late in the year, prompted by the bad publicity that had followed the crash, a technical subcommittee of the Contest Board of the National Aeronautic Association had met to alter the rules that governed multiple-lap, high-speed pylon races in the United States. The subcommittee recommended that all pilots have a minimum of 10 hours and five takeoffs and landings in the airplane they planned to race, and made other recommendations requiring pilots to complete basic maneuvers around the pylon course without a noticeable loss in altitude. In addition, the minimum race altitude was raised to 500 feet and rules were strengthened to keep spectators from congregating too close to the pylons.

No matter how well intentioned, the subcommittee's recommendations were moot. In 1950 the National Air Races were canceled. The event was held in Detroit in 1951, but a deal with that city for 1952 fell through. The Bendix Trophy race, which became an all-jet military competition, was flown from 1953 to 1957 and from 1961 to 1962. But the celebrated National Air Races had ceased to exist.

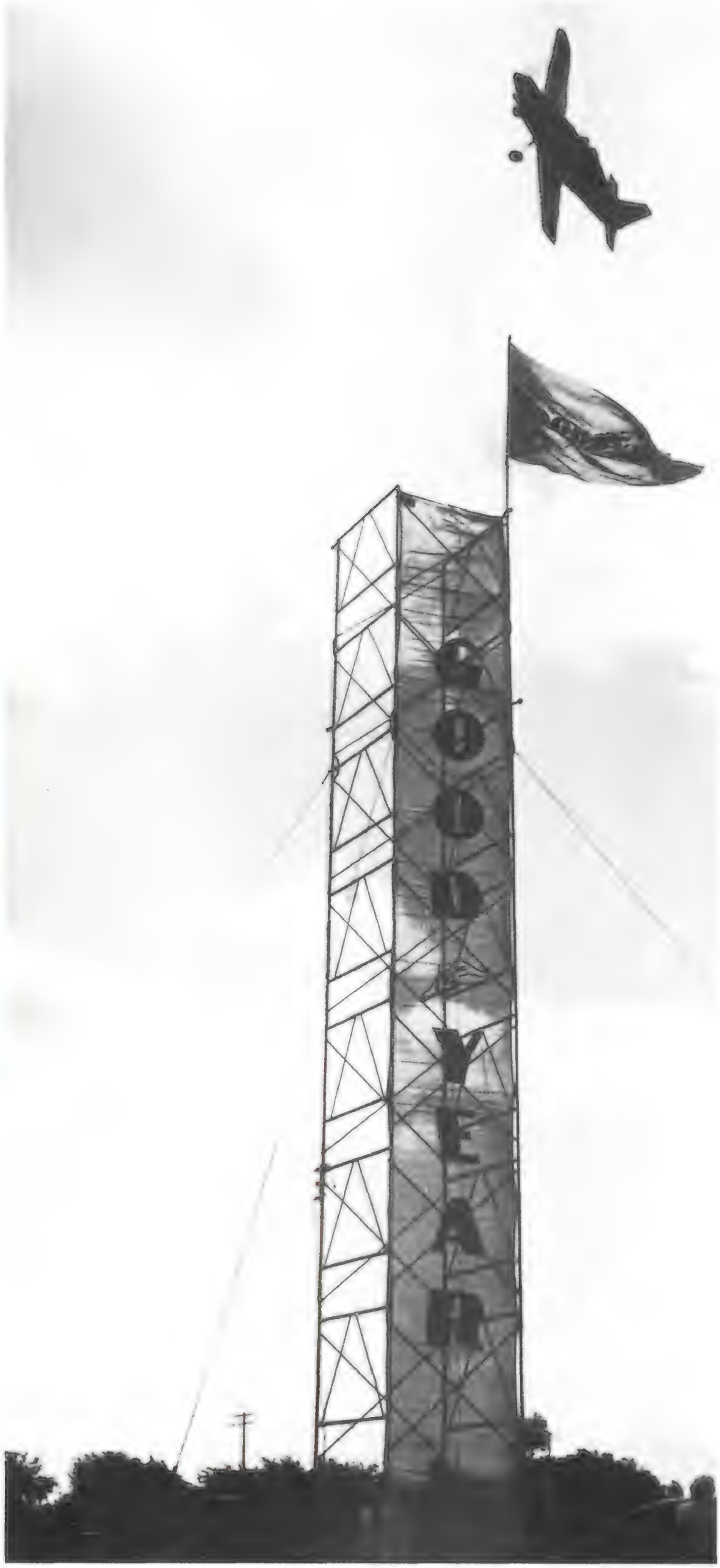
Today, National Championship Air Races—which first flew at Reno in 1964—consistently attract crowds eager to see the big warbirds of the Unlimited class thunder overhead or to cheer on racers of the AT-6, Biplane, and Formula One classes. In its Golden Age, air racing was the airborne equivalent of the Indianapolis 500, but the circumstances that endowed the sport with that excitement have changed. One thing that remains, however, is the tension


between safety and spectacle.

"Every time someone has a problem, whether it's a 'mayday' or if someone has to ditch in the field, we learn something," says Doug Albertson, former executive director of the Reno Air Races. "We're slowly but surely eliminating the hazards inherent in air racing."

Current Reno safety regulations imposed by race officials require that all pilots have 1,000 hours as pilots in command of the aircraft they race, and at least 100 hours of pylon race experience. Any aircraft designated for racing must be approved by a special technical committee.

Michael Stubbs, president of the Professional Air Race Pilots Association, which represents pilots who race biplanes,



describes how safety concerns affect the event: "I can tell you that after having raced at Reno for 12 years and helped to manage the biplane class, it's become real rigid. When I started racing in 1985, it was still not that complicated to get involved in it. But the accidents that have happened around the world have been the catalyst to more restrictions."

In 1988, a mid-air collision of the Frecce Tricolori, the Italian air force aerobatic team, killed three pilots and 33 spectators in Ramstein, Germany. Stubbs says that the effect of the accident is still being felt within the racing and the airshow communities. Insurance companies, including Lloyds of London, are now reluctant or unwilling to insure races or airshows, and the increased costs are hampering growth at Reno and elsewhere.

The nature of the sport itself poses other significant challenges. "The desert, with its wide open space, is the ideal setting," Albertson says. "You just can't fly this type of air race in populated areas—it's absolutely impossible. You'd need about 200 square miles of space to put on a race."

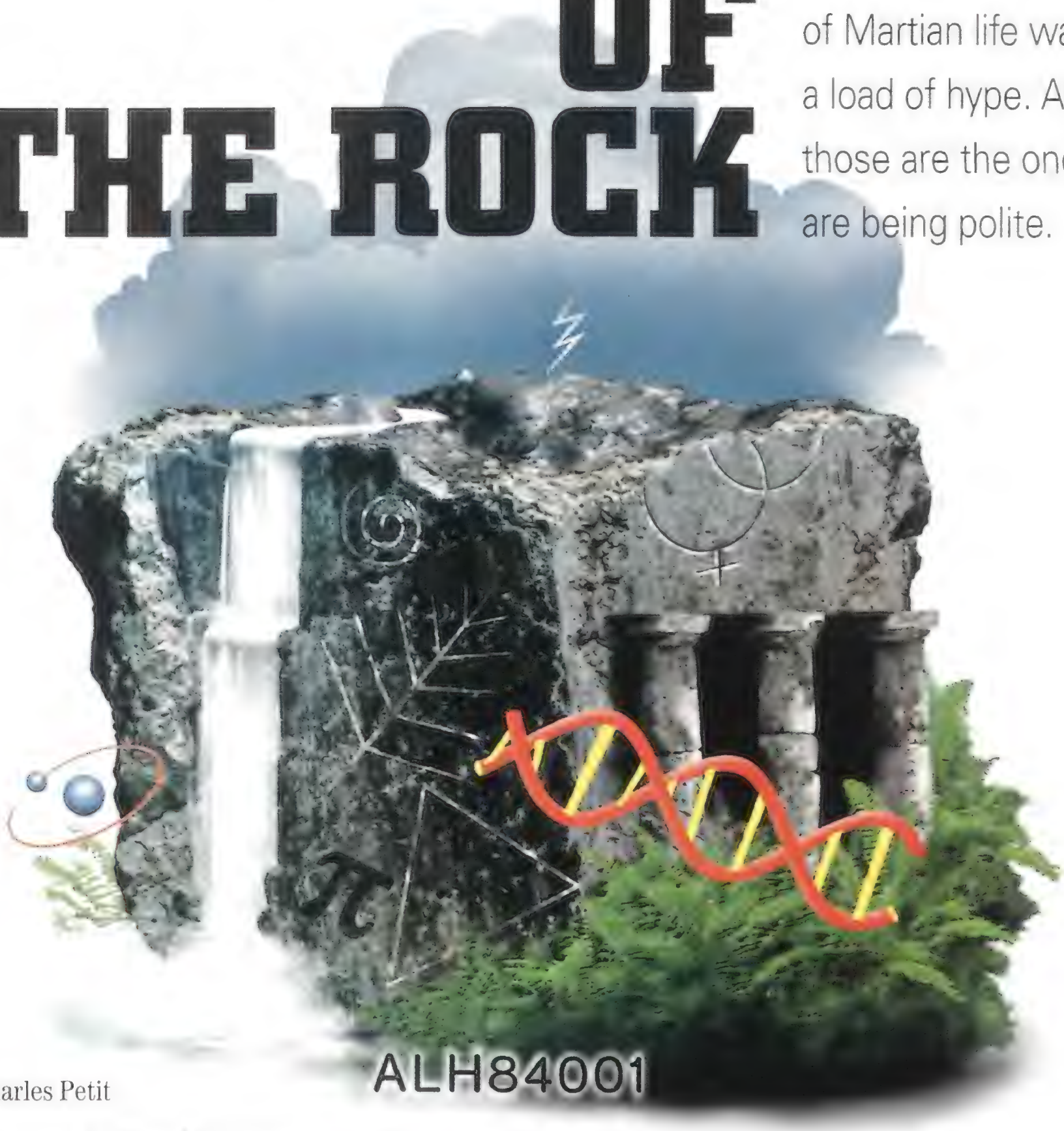
But even the open spaces around Reno are shrinking as new housing developments inch closer to the race courses, increasing the potential for accidents and conflicts. In a disturbing reminder of the Odom crash, two AT-6s collided in 1994, sending one of the aircraft into a house near the race course and killing the pilot. "People have been buying up land nearby," Stubbs says. "It's a sign of the times. There are many more houses than there were 10 years ago."

Yet Reno still draws. Albertson enjoys describing an impromptu survey of children he encountered while attending a Portland, Oregon airshow and racing exhibition. "Almost to a person, they were interested in the old airplanes—the props." People are still enchanted with aviation as competition and spectacle. Interest, while not at the level of the 1930s-era National Air Races, is still high. The Golden Age has passed, but there is still enough nostalgia for that time to bring 150,000 spectators to Reno every year.

***Racing enjoyed a brief post-war renaissance that included home-built midget racers (opposite). With the start of the 1946 Bendix race at Van Nuys Airport, the primacy of the P-51 as the best post-war racer would be firmly established (bottom), although other former fighters, like the P-38 Lightning, still provide heart-stopping excitement (below).***

# PIECES OF THE ROCK

Most meterorite experts think last summer's "discovery" of Martian life was just a load of hype. And those are the ones who are being polite.




by Charles Petit

*Illustrations by Steve McCracken*

The claim of evidence for life in a Martian rock, announced last August at a hastily convened NASA press conference following a niagara of news leaks, startled nearly everyone who heard it. But nowhere was the impact greater than in the normally low-key field of meteorite studies. There, among the scientists best suited to judge its truth, the announcement was a cosmic boulder plunging into a placid academic pond. And scholars who have devoted careers to studying extraterrestrial stones leapt like frogs startled off their lily pads.

At the Scripps Institution of Oceanography, on the University of California's San Diego campus, cosmochemist Jeffrey Bada says that when he watched the press conference on TV, "My first reaction was '*Wha-a-a-t*?' " He has studied meteorites, including ones from Mars, for years.

Bada quickly phoned colleague Harmon Craig, emeritus professor of chemistry and oceanography. Craig has, in a neighboring building, a freezer full of ice taken from Allan Hills, the same region of Antarctica where the meteorite in question was found in 1984. Bada

hacked off a hefty chunk, put it in a bottle, let it melt in the hall outside his lab, and, with colleague Luann Becker, ran it through some tests. The ice contained organic molecules exactly like those reported in the supposedly fossil-rich Martian meteorite. What's more, the researchers found the same stuff in other Antarctic meteorites with no possible connection to Mars. Bada's humdrum conclusion: not extraterrestrial life but ordinary contamination from dust in the ice, soaked up by the meteorite during the 13,000 years or so since it dropped from the sky.

Over at the University of New Mexico's Institute of Meteoritics in Albuquerque, Charles "Chip" Shearer Jr. also watched the news about "life on Mars" with great interest, seeing as he had a piece of that very rock—Allan Hills 84001—in his lab. NASA and the National Science Foundation have since suspended distribution of any more samples while they decide what further studies should be conducted, but at the time of the announcement 47 scientists around the world had pieces of the suddenly famous meteorite on loan from NASA's Johnson Space Center. And Shearer was among them.

"It's not like we slapped ourselves on the forehead and said, 'How'd we miss that?!' " he says. "But we sure took [our samples] out for another look." He and several colleagues had checked out four slices, or thin sections, of ALH84001 in mid-1995. Each is a half-inch, translucent piece epoxied onto a glass slide.

The New Mexico researchers also had been hunting for evidence of biological activity in the rock. Unlike the NASA scientists, they had come up empty. They used a method called ion probe spectrometry to analyze isotope ratios in sulfide and carbonate deposits contained in the meteorite, which may have precipitated out of warm groundwater on Mars. Earthly microbes slightly increase the ratio of a relatively rare isotope, sulfur 32, to the more common sulfur 34. It seemed a good test for life.

Five months before the NASA team's bombshell, Shearer's group had reported at a scientific conference that they saw no such enhancement of the rare isotope. In fact, sulfur 32 seems to be depleted in the deposits inside ALH84001, exactly the opposite of what one would expect if Martian biology works like terrestrial biology.

"This is just one piece of data, but it does not indicate life," says Shearer. "I have been trying to think of ways that biogenic activity could still be there and give us this result. And we've done more tests [since the NASA team's announcement]. My personal feeling is that none of these are going to pan out, though. I really think their statements were incorrect."

So upset by the talk of microbes from Mars are some meteoriticists (a hard word to say at first but what many call themselves) that they invoke the two most damning words in late-20th century science.

"Cold fusion," says Ralph Harvey, a Case Western Reserve University geologist who annually leads expeditions sponsored by the National Science Foundation to the South Pole to find meteorites. "The specter of cold fusion is hanging over all of us." When the news broke, Harvey and two colleagues, John Bradley of MVA, Incorporated in Atlanta, and Harry McSween of the University of Tennessee, were already examining their own small piece of ALH84001. They saw only natural, high-temperature deposits produced by volcanic gases—no fossils.

"I don't know whose head will be hung out to dry," worries Harvey. "But every single person who has written a letter to the editor saying 'We don't need this dreck about space' will say they were proven right if this paper turns out to be wrong."

The paper behind the fuss is "Search for Past Life on Mars: Possible Relic Biogenic Activity in Martian Meteorite ALH84001," published in the August 16, 1996 issue of *Science*, the nation's leading outlet for research reports. It represents two and a half years of work at the Johnson Space Center, largely under a shroud of secrecy in Building 31, a two-story structure of glass and concrete originally built as a laboratory for scientists studying lunar rocks returned by the Apollo astronauts. The chief authors are NASA cosmochemists David McKay and Everett Gibson, veterans of the moonrock days a quarter-century ago. A second set of authors, brought in halfway through to look for possibly biogenic, or life-caused, organic compounds, is a Stanford University team led by Richard Zare, a physical chemist and current chairman of the influential National Science Board, which oversees the National Science Foundation.

All are respected members of their disciplines. The paper went through normal peer review from outside experts before publication. And confirmation of past Martian life wouldn't even surprise many scientists, who believe the young, warm Mars was at least as well suited as Earth for the evolution of life.

So why all the rancor?

The controversy paints in vivid, billboard-size strokes the less public face of science: messy, argumentative, tentative, and, for all its devotion to logic and rigor, as passionate as a young lover's first poem. What makes this episode special is that life on Mars is so big a deal, so freighted with implications—for natural philosophy and maybe religion and certainly the proper size for NASA's ambitions and budget—that the consequences of the debate are magnified to a colossal, at times personally painful, dimension.

Despite his cold fusion comparison (others have made it too), Harvey accuses no one of fraud or even deliberate exaggeration. He concedes that the paper may be right and he wrong. But he adds, "Regardless of the [authors'] original intentions, the fact that the president of the United States spoke out on their behalf in an election year, and that the head of NASA was known to be looking to build the case for Mars exploration, means this was science being used for a political end. It scares a lot

John Kerrridge: *"They were looking at material under totally unfamiliar conditions . . . . It was the simplest thing in the world to see what one wanted to see."*

of us, frankly. We think we are all above pandering to a political goal, but it could happen."

The paper made several converging arguments for life on Mars:

• Internal cracks in the meteorite contain secondary deposits of carbonate minerals, which, the authors say, precipitated from hot water percolating through the rock near an ancient Martian hot spring. On Earth, such environments are breeding grounds for microbes.

• Infused in the carbonate are simple organic molecules called polycyclic organic hydrocarbons, or PAHs. The organic material appears more concentrated in the rock's interior—implying that it is not Earthly contamination, which would have entered from the outside in. Such PAHs can be produced by biological processes, though they also form when no life is present.

• The tiny carbonate blobs have multiple microscopic layers whose constituents are unlikely to form together if only physical and chemical processes are at work, but which often do so in the presence of bacteria.

• The carbonate has embedded in it small crystalline grains of an iron-rich mineral called magnetite, which many Earthly bacteria form.

• Most controversial of all: Microscopic images at extremely high magnifications show objects that resemble tiny fossilized bacteria—clusters of tiny spheroids, larva-shaped blobs, and even one chain of globs that looks like a segmented worm.

Taken separately, none of the data would be very persuasive, the authors wrote. But "when they are considered collectively...we conclude that they are evidence for primitive life on early Mars."


One might think that such a big splash would get a warm welcome in a field that became respectable science only in 1803, when the French Academy conceded that rocks do fall out of the sky and that such events aren't simply the fantasies of peasants (18th century chemist Antoine Lavoisier had declared them ordinary stones struck by lightning). Even today, meteoriticists are orphans wandering without a clear identity among the larger disciplines of chemistry, geology, and astronomy.

"We have been trying to make ourselves less parochial, less isolated, and are trying to interact more with other colleagues," says University of Arkansas chemist Derek Sears, who has been scrutinizing meteorites since he was a graduate student in the early 1970s at the University of Leicester in England. Sears edits *Meteoritics & Planetary Science*, the journal of the thousand-member Meteoritical Society, which recently changed its name from plain old *Meteoritics* to broaden its scope. "We needed some attention," admits Sears.

Attention they got.

The claims by McKay et al. inspired instant, intense interest worldwide, including at the White House. In the week before the news broke, NASA chief Dan Goldin was summoned for not one but two briefings before Bill Clinton, Al Gore, and then-White House chief of staff Leon Panetta. The announcement was quickly followed by the theft of a Martian meteorite fragment from a museum in Paris, outlandish million-dollar asking prices at auction (nobody, at last report, actually paid that much), a round of jokes from late-night TV comics, and a proclamation from Carl Sagan, a few weeks before his death, that if alien life had truly been found, a turning point in human history had arrived.

In November NASA announced a new initiative, the Ancient Martian Meteorite Research Program, which over the next two years will spend at least $1.5 million in additional basic studies on the 12 known Martian meteorites

Charles Shearer: *"It's not like we slapped ourselves on the forehead and said, 'How'd we miss that?!' But we sure took [the rocks] out for another look."*

(see "The Mars Mission to Earth," Aug./Sept. 1995). The National Science Foundation followed suit with a "Mars-Rock Special Research Opportunity" and as much as $1.3 million to spend.

NASA has speeded up (to 2005) its plan to gather fresh Martian rocks and bring them back on robotic spacecraft, and Goldin talks of human expeditions as early as 2012 if more work strongly suggests that life evolved on Mars as well as on Earth (and if somebody makes space travel cheaper).

Everett Gibson, the man in whose laboratory the project got rolling, recalls walking with his wife down a street in London a few months after the big press conference. "This woman comes up to me, jabs her finger in my chest, and exclaims, 'You're the Mars man!'... We were not prepared for the media blitz and the hullabaloo that followed."

Zare, the Stanford professor whose identification of PAH molecules in the rock helped make the case for life, recalls sitting with his wife in a Palo Alto coffee shop in mid-August: "We heard two arguments at nearby tables. One was about why the San Francisco Giants can't win. The other was a heated debate over the possibility of life elsewhere in the universe, and they were talking about our rock!"

Climbing the two flights of stairs leading to his laser spectroscopy lab, Zare blurts out, "I keep thinking about these crazy things, these Mars rocks. We get pieces of them here, and we never had to worry about security or anything before. Now we hear people are asking these huge prices for them. I mean, it changed things, it's different. I keep thinking I should have a safe or guards or something."

He probably needn't worry. Your average thief would have no idea where in the laboratory's mountains of equipment, files, bureaus, benches, and boxes to look—or even how to tell one grapeseed-sized chunk of mineral mounted on a microscope slide from myriad others. But watching Zare reverently handling one chip, you can tell that it's special. A look through a microscope shows a dull gray silicate rock with a vaguely granular structure. Orange flecks gleam on its surface—carbonate deposited in hair-thin cracks, long after the main rock had hardened from magma under a Martian volcano. Those flecks, if Zare and his colleagues are right, are the final resting place of ancient Martian beings. "NASA should set up microscopes in shopping malls, with pieces of this rock in them, just so the public could see them," Zare says.

On the second floor of the Charles Arms Laboratory—a graceful old mock-Spanish hall at the California Institute of Technology in Pasadena—is a door with a brass plaque over it reading "The Lunatic Asylum." In the lab behind the door, under the supervision of Gerald Wasserburg, now 70, lunar rocks from the Apollo program underwent some of their most important scrutiny. Wasserburg, a past president of the Meteoritical Society, still loves his rocks from space. "When I need therapy, I just go in the lab and look at those rocks and feel joy in my life," he says.

He isn't sure what to feel, though, about the latest news from Mars. "I think the view from the [meteoritical] community is as follows: Here, finally, some attention is being paid our field. Now lo and behold, we don't hold it in such high esteem that we applaud it and say it is really certain. It is highly speculative and not necessarily the truth.... One doesn't want to shout down these guys for getting this attention. So you don't want to dump on it. On the other hand, there is the question of the truth of it."

Many, actually, do not mind dumping on it. In the first four months after the news broke, "I must have had phone calls, e-mails, and other communication from 40 to 50 people [in the field], and not one of them showed anything but serious skepticism," says Derek Sears. He does not think much of the report himself. If it had been submitted to his journal, he says bluntly, "I'd like to think we would have rejected it."

ALH84001

Some of the journal's readers, in fact, "are downright hostile" to the authors of the report. Objections are multiple, including assertions that the carbonate formed from gases too hot to support life, ridicule of the supposed fossil microbes as purely natural rock blobs and far too small anyway to have ever been something living, and a general assertion that the evidence is too ambiguous to support any strong conclusion.

Said McKay recently of his post-announcement life: "We have had plenty of conflict. Most of it has been on scientific grounds, but there are a few people whose reactions have surprised me, because they have been basically hostile, almost to the point of name-calling."

Some of the exchanges are indeed personal. Among the barbs gathered during interviews on both sides of the issue: "He wouldn't know the truth if it bit him," "He wouldn't know a meteorite if it hit him," "I am appalled he is still in the business."

Everyone seems to have an opinion, usually a strong one. "The data are just pitifully short of convincing," says cosmochemist and meteoriticist John Kerridge, sitting in the bright early-winter sunshine of San Diego as surfers carry their boards down from the University of California campus where he works. "From the moment I read that paper, what was initially skepticism turned to absolute conviction they are wrong." Kerridge is intimately involved in plans for exploring Mars; two years ago he led a NASA committee that spelled out strategies for finding life on the planet.

He thinks he knows how the McKay group were led astray. Ironically, Kerridge surmises, it was due to the extraordinary precision of their instruments. Kathie Thomas-Keprta, an electron microscopist at the Johnson Space Center, had been helping McKay and Gibson examine the tiny "fossils" in the rock. At first she used her own laboratory's scanning electron microscope, but eventually she turned to a much more powerful one that had been installed at the space center's engineering department to study fragments of the space shuttle *Challenger*. It brought into focus details as small as a few tens of nanometers, or millionths of a meter, wide—dimensions hundreds of times smaller than what biologists are accustomed to seeing when examining fossils.

"They were looking at a material under totally unfamiliar conditions... looking at nature at a scale at which it had not been probed before," says Kerridge. "Everything was novel. It was the simplest thing in the world to see what one wanted to see.

"You can draw a beautiful historical analogy here with Percival Lowell," he continues. "His [Martian] canals were just like this. They were phenomena just beyond the resolution of his telescope. He saw what he wanted to see, and similarly, McKay and Gibson saw fossils because they were looking for fossils."

To many skeptics the affair evokes a feeling of déjà vu; reports of evidence for life in meteorites surface every generation or so. In 1932, Charles Lipman, an eminent bacteriologist at the University of California, discovered "spores" in a meteorite. He even cultured them and grew colonies of bacteria that he declared to be from somewhere else. He went to his death in 1944 convinced he was right, long after colleagues concluded his extraterrestrials were ordinary Earthly cocci and bacilli that had invaded the rock after it landed.

A few days after the NASA news conference, Ed Anders, an emeritus professor of physical sciences from the University of Chicago, sent his son an e-mail from Bern, Switzerland, where the former president of the Meteoritical Society and his wife had retired five years ago, thinking his battles over life in meteorites were over.

"Mars has intruded in my life," Anders wrote his son. "I was politely skeptical at first, and became much more skeptical still after finding out who the authors are, watching the news conference, and reading the article.... At first I thought I could sit out this controversy, as there are many other potential whistleblowers available. But...I realize that much of the contrary evidence is from the 1960s and 1970s, often from my lab. As people tend to ignore papers older than three years, much of this evidence will not be considered unless I speak up."

Anders has been there before. He almost single-handedly killed the last episode of supposed evidence for alien life in a meteorite: the "organized elements" of Bartholomew Nagy.

Nagy, a well-regarded chemist at Fordham University, reported in the November 18, 1961 issue of the journal *Nature* that he and a colleague had discovered spore-like particles in a meteorite of the class called carbonaceous chondrites. They definitely looked biological, with regular geometric shapes, but resembled no known Earth organism. Nagy took his slides to conferences of botanists and biologists, and none could identify them. "The pictures were quite striking," Anders agrees. "They looked like they had cell walls and nuclei, and one even had what looked like an appendage."

Anders and Nagy were already public antagonists when the *Nature* paper came out. Anders had challenged an earlier report by Nagy that organic molecules in a meteorite resembled petroleum, or even butter, implying that the rock had come from a world where living things dwelled. So when Nagy upped the ante with his organized elements, Anders took another look—and soon discovered the mistake. Nagy had examined his bit of sky stone during a New York summer. Anders and coworkers later looked at samples from the same meteorite during a Chicago winter. The suspicious shapes were absent. The organized elements were ragweed pollen, deformed by chromic acid in a dye Nagy and his colleagues had

*Derek Sears: "I must have had phone calls, e-mails, and other communication from 40 to 50 people [in the field], and not one of them showed anything but serious skepticism."*

used to make them easier to see in the microscope.

Anders speaks for many skeptics in rejecting the chain of reasoning by McKay, Gibson, and their co-authors: "Five maybes don't make a certainty!"

"Here is what I think happened," he adds. "It is scientific mob psychology. You would think that having people from several different fields would increase the chance of some work being done correctly, but it doesn't work that way. Maybe scientist A thinks the part he knows about is marginal, but he is impressed by B's work. And B isn't sure about his stuff, but is persuaded by A's and C's work. And so it goes." A daisy chain of doubt turns into true belief.

After the paper came out in *Science* last year, Anders fired off an e-mail to McKay. It started pleasantly: "First, I want to congratulate you and your coauthors on some outstanding aspects of your work, especially your superb data and techniques." Then he cut loose. He asserted that in nearly every instance, the observations could as easily be explained by nonbiological processes as by an ancient population of Martian microbes. At one point, he called the tiny formations in the sample "turd-like shapes" and referred repeatedly to "distressingly biased" interpretations and "illogic."

A somewhat more temperate version of his e-mail eventually ran among an exchange of views in a subsequent issue of *Science*. Gibson, one of the targets of the criticism, chose to accentuate the positive: "The first paragraph of Ed's letter is amazing," he says. "It congratulates us! That is a win statement from the word go. Knowing him, that he said anything positive is wonderful."

Many doubters, claims Gibson, have never seen the data, or are just "protecting their own turf," or both.

"We feel we are right," he adds, "and the more evidence we get, the stronger our beliefs become. Science is going to win on this one. This is not cold fusion, this is not polywater.... We know our lines of evidence are solid. We kept quiet for two and a half years—we had the answer in one year, and we spent a year and a half trying to disprove ourselves."

McKay has a fallback position in case his group's paper is proven wrong. Eventually, somebody, or some machine, will bring back samples from Mars. When that happens, scientists will need to have a good idea of what to do with them. The current barrages of criticisms, counter-criticisms, and follow-up research are "a dress rehearsal for the Mars sample return, at about a magnitude greater level of detail than would be possible if NASA just had us practicing for the real thing. This *is* the real thing."

Scientists in the field say the intellectual battle over the McKay-Gibson claim is likely to last at least a couple of years. Gibson himself thinks it will be more like five to ten years before any verdict is reached.

Not all the skirmishing is hostile, as witnessed by a chance meeting on the unearthly, windblown ice of Antarctica. There Richard Zare, the Stanford chemist and coauthor of the controversial paper, encountered Ralph Harvey, the staunch Case Western Reserve skeptic, three months after the big announcement. As top dog at the National Science Board, Zare was inspecting National Science Foundation-funded programs on the frozen continent. Were it not for his bureaucratic duties, he would have had no reason to actually visit the place where his famous Martian rock was discovered.

Zare arrived at a search location called Elephant Moraine, near the Transantarctic Mountains. He stepped from the helicopter dressed in typical South Polar garb: a very heavy red parka over several layers of sweaters, thermal underwear, three gloves on each hand, a ski mask, and goggles. He scrunched across the thin blowing snow on fat "bunny boots" hiding still more layers of wool and nylon. It was minus-22 degrees Fahrenheit in a 30-mph wind. Harvey, who had been leading a team of searchers there for many days already, met Zare and the two clasped mittens.

"The place looked like a golf course, with flags marking the meteorites," Zare recalls. "I expected snow. Instead we were on hard blue ice." Within minutes, he said, "I felt deep pain. It was so cold. But these guys work out there for weeks at a time. I disagree with Harvey about ALH84001, but my hat is off to him and that effort. It was one of the most impressive things I have ever seen."

ALH84001

VIETNAM MEMOIR

# PLAUSIBLE DENIAL

## "IF SHOT DOWN AND CAPTURED, ARE YOU WILLING TO BE DISOWNED BY YOUR GOVERNMENT?"

–Question put to volunteers for the U.S. Air Force's first combat mission in Vietnam

by Susan Katz Keating

ILLUSTRATION BY PAUL SALMON

*A Farmgate team prepares to drop ammunition to a South Vietnamese army outpost. The unit used U.S. Air Force C-47s to dispense supplies in parachuted crates (below). Like all the unit's aircraft, the C-47s bore markings of the South Vietnamese air force.*

In the fall of 1961, U.S. Air Force Colonel Benjamin King, a World War II ace and the survivor of a daring escape from behind enemy lines, assumed command of a newly formed unit stationed at an old French airstrip in South Vietnam. On one of his first missions King flew a C-47 dropping propaganda leaflets over villages near the air base. His copilot was a colonel in the Vietnamese air force by the name of Nguyen Cao Ky.

COURTESY PAUL DONNER (2)

Neither the pilot nor the copilot could speak each other's language, so that day's mission, like many others, was conducted with little clear communication. When the flight came to an end, King, without speaking, simply headed back to land at a short airstrip.

But he had to abort the landing. "I was too long and too hot, and I had to give it power to go around," King recalls. The second try was no better. "I was still too hot, so I went around again." As King prepared to make his third attempt, he glanced over at copilot Ky, who would later become prime minister of Vietnam. "He was just sitting there, shaking his head. I took my hands off the wheel and I asked in English, 'Can you do any better?' " King pauses as if to savor the coming punchline. "Ky went around and landed that C-47 so short, he had to give it power to get it to the end of the strip." With a laugh, King adds, "And I was supposed to be teaching *him* to fly."

Stories like King's illustrate the irony behind the cover story for his unit—that the Americans were advisors, in the country to train pilots of the Vietnamese air force. "More than 25 years after the fact," says King, "I can say this: We never trained a Vietnamese pilot."

King's unit was the first detachment of U.S. airmen to fly combat in Vietnam. Its code name was Farmgate, and beneath its training cover, its mission was to stop communist guerrilla forces in the south. "Farmgate was a highly classified mission to provide close air support to Vietnamese ground forces and to attack the Viet Cong," says one of the operation's first pilots, retired Major General Richard Secord, who later became a deputy assistant secretary of defense under Ronald Reagan.

The effort was an outgrowth of cold war saber rattling, specifically an ominous 1961 speech by Soviet Premier Nikita Krushchev announcing the USSR's intent to support wars of "national liberation," such as "the armed struggle waged by the people of Vietnam."

In South Vietnam, attacks by communist guerrillas supported by North Vietnam sharply escalated in the late 1950s. In 1959, an assassination campaign targeted at South Vietnamese government officials claimed 1,200 lives; in 1961, the number rose to 4,000. Terrorist attacks—usually conducted at night—on villages, military outposts, government offices, and American convoys and servicemen in Vietnam were also rising.

Krushchev's speech made a great impression on newly installed President John F. Kennedy, who urged the U.S. military to expand its counterguerrilla capabilities. As a result, the Army beefed up its Special Forces, the

Navy formed the SEALs, and in April 1961, the Air Force established the 4400th Combat Crew Training Squadron, nicknamed Jungle Jim.

Jungle Jim was authorized a scant force of propeller-driven aircraft—C-47 transports, B-26 light bombers, and T-28 trainers—that seemed more appropriate for a museum display than for the modern U.S. Air Force. The aircrews had none of the sophisticated electronic aids their colleagues relied on. "We flew in all kinds of weather...," Farmgate T-28 pilot Frank Gorski recollected in a formerly classified 1973 Air Force interview. "If you wanted to get someplace, you just picked up a canal and went. That was your navigation system. Flew time and distance. Kept one eye on the fuel and one eye out the window and pressed on."

But the old C-47s and T-28s, which flew low and slow, were actually better suited than high-speed craft for the types of activities an airborne counterguerrilla effort would conduct: dropping supplies and propaganda leaflets, for example, or bombing and strafing small, dispersed targets like huts or boats. The aged airplanes would also be inconspicuous in the Third World nations whose forces the Jungle Jim crews would assist.

In Vietnam, the missions would be flown by pilots wearing plain flightsuits that had been stripped of all identification and insignia, and they would be conducted in complete secrecy—both because they violated the 1954 Geneva Accords, which prohibited the introduction of foreign troops into Vietnam, and to withhold knowledge of the operation from the American public.

The Farmgate mission was so sensitive that even now some of the official documentation remains classified. More than one pilot contacted for this article echoed the comments of former C-47 pilot Bill Brown, who prefaced his remarks with a hesitant "I'm not sure what you're entitled to know."

Not that the documents were plentiful to begin with. "In those days, a lot of times the special operations folks simply didn't keep records," says writer Michael Haas, himself a former air commando, as the men of Farmgate were later known.

The information that is available reveals that in the spring of 1961, the Air Force sought volunteers: elite pilots with at least 5,000 hours of flight time and enlisted personnel, including mechanics, armament specialists, and combat controllers, who ranked among the top two percentile in their specialties. Potential recruits were told only that the program was highly classified and that it would remain so for 25 years after it ended.

COURTESY JOE KITTINGER

*To perpetuate Farmgate's cover as a training operation, its pilots were required to carry a South Vietnamese national, such as this unidentified young man, on combat missions. But Benjamin King (below) says, "We never trained a Vietnamese pilot."*

More than 3,500 men volunteered.

"The recruiting was rather unique in my 38-year Air Force career," says retired four-star General John "Pete" Piotrowski, who in 1987 became the head of the North American Aerospace Defense Command and the U.S. Space Command. A recently promoted captain at the time, Piotrowski was told to meet with a general who was visiting Luke Air Force Base in Arizona. "When my turn came I was ushered into a small office, dark except for a light that shone on the interviewee," Piotrowski recalls. "The officer conducting the interview was barely visible—a shadowy figure in the darkness."

The interviewer asked three questions: Are you willing to fly old obsolete aircraft? Are you willing to fly combat? If shot down and captured, are you willing to be disowned by your government? With some hesitation over the third question, Piotrowski answered yes to all three, after which the interviewer said only, "You may go now."

Those who made the first cut were given a set of increasingly bizarre tests, which included standing for long periods on ice while naked and culminated in a three-week mountain survival course and an excruciatingly realistic mock prisoner-of-war camp.

Bill Brown, who tops six feet, spent about three hours of POW training stuffed inside a refrigerator-size cubicle. "It was torture treatment in a way,"

COURTESY BENJAMIN KING

Brown says. "But I stuck it out."

Most did not. Says King: "The Pentagon told me that of the initial 3,500 applicants, only about 350 made it. They were an amazing group of people."

The men of the 4400th were taught to fly the air commando way. While in training at Eglin Air Force Base's Hurlburt Field in Florida, the pilots used C-47s to practice short-field landings, airborne loudspeaker broadcasting, leaflet drops, parachute drops of men and equipment, and night operations, including landing on short, unprepared strips in the dark. In T-28s and B-26s, they practiced strafing and bombing.

Once trained, the new unit fielded one group to the African republic of Mali and another, Detachment 2, to an unfamilar hot spot in Southeast Asia. "This was some months after the Bay of Pigs episode," says Secord. "We thought we were going to Cuba. Imagine our surprise when we wound up in Vietnam."

By then code-named Farmgate, the initial Detachment 2 consisted of 41 officers and 115 enlisted men, each of whom had been assigned a secret clearance and authorized to bear arms. The unit was allotted a portion of the 4400th's fleet: four C-47s, four B-26s (which served in World War II as the Douglas A-26) and eight T-28s, which would be used as fighters.

Officially on 179-day temporary duty (that status would change for succeeding crews), the men and their airplanes converged on Bien Hoa, a languid, colonial-style provincial capital about 30 miles northeast of Saigon. The airstrip, which was surfaced with pierced-steel planking, was home to the First Fighter Squadron of the fledgling Vietnamese air force, whose members the Farmgate men were to "train." The Vietnamese were stationed on one side of the field, the Americans on the other.

The atmosphere at Bien Hoa was thick with secrecy. The men of Farmgate were confined so as to conceal the fact that Americans were there; the U.S. aircraft were disguised in Vietnamese air force colors. All news agencies were forbidden. Not even the men's families knew where they were stationed; nor did the rest of the Air Force know what they were up to.

Sometimes the pilots themselves did not know what they were truly being used for, as evidenced by an incident that took place in early November 1963. "I had just taken off from Bien Hoa in a B-26," Joe Kittinger says, "when I happened to look over to the side and saw the most amazing thing: Airplanes were bombing the palace in downtown Saigon! I said, 'My Lord, what is happening?' "

Kittinger immediately radioed the Air Force command center in Saigon to relay the information. He was instructed to report what he saw. It was the beginning stages of the coup that would result in the overthrow and assassination of South Vietnamese President Ngo Dinh Diem.

"I could see tanks and bombing, and a battle was going on," says Kittinger. "They kept running me from place to place to see what was going on. I was an airborne command post." The amazed pilot remained aloft nearly four hours before he began to run low on fuel.

In retrospect, Kittinger believes that his commanders had intended for him all along to witness the coup, which the United States—although it had earlier supported Diem—had come to believe was necessary.

"The only people who knew the truth about our assignment besides the 4400th commanders and the deployed troops themselves were the Joint Chiefs and President Kennedy, and they weren't talking either," wrote Secord in his autobiography, *Honored and Betrayed.*

The result was a command structure that, in its beginning covert stages, sometimes confused even the Farmgate leadership. "There was the matter of who we reported to," King says. "A lot of people had a lot of questions about that, including me. We were serviced and supplied theoretically through Ninth Air Force. I never met anyone in Ninth Air Force. I took my orders from two lieutenant colonels in the bottom of the Pentagon building. It seemed odd to me at the time, given that I was a full colonel."

But the unusual command structure worked to the airmen's advantage as well, as evidenced by an incident involving, of all things, the commandos' headgear. The episode originated in late 1961 when King realized that even though the men of Farmgate had been driven almost to the limits of human endurance in preparation for their clandestine mission, they had not been properly equipped for the extremes of Southeast Asian weather.

"It was hotter than the hubs of Hell," says King, and rainy, and for headgear the men had been issued only baseball caps. As Farmgate's first commander, King jettisoned the caps in favor of the more practical broad-brimmed cowboy

*Mechanics at Bien Hoa remove a B-26's engine. Holdovers from World War II, the old bombers were later strengthened for low-level attack after several lost wings in mid-air.*

COURTESY PAUL DONNER

COURTESY BILL BROWN

*Supplies destined for a village of Montagnard tribesmen are unloaded from a C-47. Farmgate combat controller Charlie Jones (below) patrolled the jungle with the tribesmen to direct air strikes against the Viet Cong.*

hats worn by the Vietnamese air force.

Later, after King had returned to 4400th CCTS headquarters at Hurlburt Field, Lieutenant Colonel Robert Gleason took command of Farmgate. Gleason soon hosted a high-powered delegation from CINCPAC (Commander in Chief, Pacific), which included no less a figure than Admiral Ulysses S. Grant Sharp. Sharp apparently was unaware that he did not have operational control over the unit. He ordered the men to stop wearing "those crazy cowboy hats."

Aiming to ward off trouble, Gleason sent a hasty message that night to King, describing the hat order. "Within 24 hours I received a message sent through channels, including CINCPAC, stating that the cowboy hats had now been declared official USAF headgear for commando units." Gleason says. "It was signed by Curtis LeMay, Chief of Staff, United States Air Force."

Of course, the unit had far weightier concerns. "One of the first things we had to contend with was the methods of the Vietnamese air force," Gleason says. "They had been trained under the French colonial system, and the French were very gentlemanly about fighting wars. They wouldn't fight at certain times, including at night. The enemy was well aware of the reluctance of the VNAF to fly at night, so they fought at night and wiped out the VNAF as a potential threat."

The Americans knew that making headway against the guerrillas would require flying when they could not see what was going on in the shadows below. The solution came after a sergeant mentioned that illumination flares had been used at night in Korea. Gleason and Piotrowski, who had been named the Farmgate armament officer, set to work on the suggestion. After some experimentation, a system using magnesium flares was put into use.

To illuminate the target, three or four parachuted flares would be dropped from the cargo hold of a C-47 at an altitude of about 1,500 feet. T-28s or B-26s would then immediately follow to strafe or bomb the target. By the end of 1963, tactics had become so refined that flareships were on constant alert, and most South Vietnamese army units in the IV and southern III Corps—the nearest of the four tactical zones U.S. military advisors had created—could get night illumination plus close air support within 20 to 60 minutes.

The system made its mark on the enemy as intended. "Initially, it was merely sufficient for a flareship to appear over a besieged position and expend flares to cause the VC to break off an attack," read a then-classified 1967 Air Force tactical evaluation report.

Night operations also led to a novel signalling technique. "We worked out a system with [the South Vietnamese army] at these little outposts, where they would set up a flaming-pot system pointing out the direction of the enemy," King says. "Later on it became a flaming metal arrow."

COURTESY PAUL DONNER

The large arrows, covered with woven bamboo, were laid directly on the ground. "They would point the arrow in a certain direction, and it would come over the radio: 'Drop your ordnance 200 meters away from the fire arrow,' or 100 meters, or some such," says Farmgate pilot Joe Kittinger.

"Sometimes it worked very well," says King. "Other times it didn't work worth a damn." When it didn't work, the fire arrows became merely another part of the confusion. Gorski recalled one such occurrence, while on a night mission in support of a besieged South Vietnamese fort shrouded in fog. "We could circle above this dude and pick up the fire arrow, but as soon as you tried to get some sort of angle on it, you lost it. Of course, the flareship was dropping flares and they would go down in the fog and that would really play havoc with your sight," he said in 1973. "But we would try everything we could because we had a limited resource, and we did things that maybe now we would say were a little bit harebrained or foolish."

For all their ingenuity, however, the Americans could not escape one cumbersome requirement: To keep up the appearances of a training role, they were required to fly all combat missions with a Vietnamese "trainee" on board. In contrast to the skills of the longtime Vietnamese pilots, whom King characterizes as "some of the best qualified I flew with," new classes of VNAF fliers

had not been properly certified.

"Actually, they never were allowed anywhere near the controls of the aircraft," says Bill Brown. When possible, the crews restrained the new aviators with safety straps to prevent them from reaching the controls. Otherwise disaster lurked. Secord and his Vietnamese copilot barely escaped crashing when the terrified backseater repeatedly grabbed the controls of Secord's T-28.

COURTESY PAUL DONNER (3)

*Farmgate crewmen devised a simple aid to pilots flying night missions: When set ablaze, the "fire arrow" pointed the way to the enemy. At right, a Farmgate officer inspects a village's defensive artillery with local troops.*

Gorski reported having trouble with a young pilot who could not seem to control the aircraft: "Every time I'd give him the darn airplane, he'd just go completely bananas all over the sky," he told Air Force interviewers in 1973. A subsequent debriefing of the pilot by Gorski revealed unsettling information. "I asked him how much time he had," Gorski said. "He said he had about 500 hours.... I said, 'How much solo time do you have?' He said, 'I've got one hour solo time.' "

Often the backseaters weren't pilots at all. "We'd carry anybody that was available," B-26 pilot Roy Dalton recalled in a formerly classified 1973 Air Force interview. "We'd go over to the Vietnamese base commander and he would give us the guy who was sitting around either typing or sweeping the floors—and he would fly with us."

The Americans were further hampered by the requirement that all strikes be made at the direction of an airborne Vietnamese forward air controller, theoretically so that he could "authenticate the target," Gorski says. The FAC was essential to the mission: "Once we showed up on the scene, if the FAC wasn't there, we didn't strike."

Sometimes, the FAC's target selection mystified the Americans. "We were totally at the mercy and the direction of the [Vietnamese lieutenant] that came along and said, 'Hit this target!' " Dalton recalled. "We had no intelligence of our own, no hard intelligence, on who we are hitting."

Aside from these concerns, the commandos had problems communicating with the FAC. At times the radio did not work, or there was language difficulty. T-28 pilot Edwin "Jerry" Shank described the system in a letter home: "One of our complaints [to a representative Secretary of Defense Robert McNamara sent to Vietnam] was that we can't understand the air controller, so he suggested that we learn Vietnamese. We said we didn't have that much time, so he suggested we stay here for two years. A brilliant man. He's lucky to be alive. Some of the guys honestly had to be held back from beating this idiot up."

By this time, the escalating hostilities in Vietnam were attracting worldwide attention. The U.S. government had long been denying that U.S. troops were engaged in combat in Vietnam—at a news conference held in January 1962, President Kennedy issued a flat denial when asked the question—but reports in the U.S. press made clear that American trainers and advisors were firing and being fired upon. In March 1962, the *New York Times* reported that U.S. pilots were "engaged in combat missions with South Vietnamese pilots in training them to fight Communist guerrillas."

Farmgate became increasingly subject to public scrutiny. "Reporters were snooping around, and they would watch the airplanes take off," says Farmgate medic Hap Lutz. "They discerned that the Vietnamese on board weren't pilots." Ironically, journalists were confused by markings on the aircraft. The Vietnamese air force insignia so closely resembled that of the U.S. Air Force—only a subtle variation in color distinguished the two—that the reporters described the Bien Hoa aircraft as having American markings, thus inadvertently revealing the truth about which nation actually owned them.

Publicity only made the Farmgate operation more complicated and cumbersome to carry out. As more Air Force personnel became aware of Farmgate's activities, King says, "all the bureaucracy started, and we got orders from everybody." Over the years, wrote Air Force historian Carl Berger, Farmgate's simple rules of engagement "grew into many pages of detailed operating instructions telling Air Force pilots what they could or could not do in combat."

Other problems plagued Farmgate.

The dangerous missions had produced a high rate of casualties: In 17 months from early 1962 to mid-1963, 16 Farmgate crewmen were killed in action. But crews in some B-26s and T-28s were dying as a result of what some euphemistically termed "equipment failure." In fact, the airplanes were falling apart in mid-air.

"These airplanes had been used in World War II and Korea, and they were tired," Kittinger says. "And we were using them as fighter-bombers." The old airframes simply were not up to the new task: "The wings started coming off them.

"If a wing comes off, you get just violent roll," Kittinger says. "The G-force would preclude you from doing anything. You can't get out. You don't have a chance."

In February 1964, after a number of B-26 losses, a wing failed on a B-26 during a demonstration at Hurlburt Field, killing two crewmen. The entire B-26 fleet was grounded.

There was a brief journalistic outcry surrounding the problems with what Farmgate crews irreverently termed the "folding-wing version" of the B-26. Soon after the Hurlburt Field incident, *U.S. News & World Report* published some of Jerry Shank's letters home, in which he complained about conditions in Vietnam. Among them was an indictment of the B-26: "That airplane is a killer." The letters were all the more arresting because they had been supplied to the magazine by his wife shortly after Shank had been killed when one wing of his T-28 sheared off during a bomb run.

Scarcely had rebuilt B-26s, intended to meet the demands of counter-guerrilla warfare, entered the inventory when, in mid-1964, President Lyndon Johnson signed the Tonkin Gulf Resolution, which authorized the increased use of American forces in Vietnam. In May 1965, the Army's 173rd Airborne Brigade arrived at Bien Hoa. The airmen were followed by B-57s, F-100s, C-130s, F-102s, and more, as well as by surface-to-air Hawk missiles, a medical unit, and a civic action program to perform charitable duties for the civilian population.

The Farmgate operation lingered on for a time, but the arrival of the regular Air Force overshadowed it. Fittingly, Air Force historians can offer no precise date for the operation's end, although its parent organization—the 4400th Combat Crew Training Squadron—was deactivated in October 1969.

Farmgate crew members still speak of the waning of the operation with regret. "With Farmgate, we tried to contain the war as a counterinsurgency operation," Gleason says. "But events sort of swarmed in and changed the world. What we dreaded most was what happened, which was the conventionalization of the war. You can't fight Viet Cong in the field with B-52s or with huge battleships patrolling offshore."

"Things just got bigger," explains former C-47 crew chief Bill Conklin. "It wasn't Farmgate anymore. It was a war."

COURTESY JOE KITTINGER

*A Farmgate B-26 navigator captured the aftermath of an air strike (above). Below, a peaceful village scene belies the escalating hostilities in Vietnam. As the war grew, Farmgate's role diminished.*

# NATURAL SELECTION

The careful removal of trees by helicopter keeps New Zealand's rainforests thriving.

by Tom Harpole

*Photographs by Geoffrey Clifford*

Here comes Wayne Pratt again. Banking closely along a heavily timbered foothill in New Zealand's Southern Alps, he's at the controls of a seven-ton Russian helicopter, trailing an 11,000-pound log that twirls at the end of a 200-foot cable. The landscape of undulating evergreen ridges dwarfs the big chopper and its dangling load. I've been watching this helicopter logging operation for several days, and when Pratt makes his approach from half a mile away, the log looks no bigger than a pencil held at arm's length. I've been told that the Russian helo, a civilian Mil Mi-8 MTV, lifts five tons (roughly the weight of a school bus), that it is 83 feet long, and that the cable attaching the log to the helicopter weighs 200 pounds. But somehow it all looks too fleet and graceful to involve such weights and measures. As the Mil rumbles by, I'm beginning to understand that Pratt is making a big deal look easy.

Now at an altitude of 250 feet, the Mil rears back and starts to decelerate, the locomotive clamor of its 69-foot main rotor precluding even shouted phrases between the workers waiting on a clearing below for its arrival. The log descends at 10 feet a second—any faster and the helicopter would fall into the turbulence of its own rotor wash. When the lower end of the log thunks down, the ground trembles a hundred feet away. Tension on the cable slackens momentarily; then the 40-foot log falls into the slack, and the great chopper hammers the air harder. To compensate for the jerk on the airframe, Pratt adjusts the throttle, simultaneously lowering the thick upper end of the log, still pinched in the jaws of an 800-pound grapple.

The grapple (think of enormous pliers with barbed tips) can open only when the log's weight no longer pulls its jaws closed. Pratt makes minute corrections in the chopper's hover, then swings the log and lowers it sharply. The grapple falls open across the log it has just released, its jaws ratcheting six feet apart. A second later, Pratt activates a solenoid that locks it open.

*A New Zealand logging company uses a sturdy Russian Mil Mi-8 MTV to harvest ancient redwoods.*

All this activity has whipped the morning mist into a ring of vortices around the rotor tips, which coalesces into a column of wind descending below the hovering helo. The wind hits the ground, lifting and propelling dirt and wood chips in a widening gale that can flip off a snug hard hat and blow it 40 feet up the road.

After a brief pause, the grapple lifts jerkily, then streaks up over the trees that edge the landing area, a rectangular patch of dirt about the size of a basketball court. A "bushman," or logger, jogs over to the log and uses a chainsaw to remove remaining limbs. A tallyman records the log's estimated weight, which has been scrawled in red crayon by the bushman who felled the tree. Then they scramble out of the way as the rotor wash dissipates. A loader operator notes the size of the log, then "hot decks" it into the appropriate pile, where it awaits shipment to a sawmill.

And here comes Pratt with another $1,000 load.

In the amount of time it took to read this job description, Pratt has flown a mile back up over the hilltop, extracted another five tons of wood from an essentially undisturbed forest canopy, and returned. The loader retreats to a neutral corner, while the bushmen clamp hands over hard hats and brace for another round.

Under contract to Timberlands West Coast, a New Zealand government-owned enterprise, Pratt, a New Zealander, and the chopper's four Russian crew members roam up and down some 200 miles of the South Island's west-coast rainforests. They move from site to site, lifting logs that local bush gangs have harvested in forests near their hometowns. South Island hoteliers always welcome the peripatetic crew, who make ideal guests: They are hungry, well-heeled, and sober. In the hours before dawn, they leave their rooms quietly and head out to the nearby forest. Then—with luck—in two 10-hour days, they'll lift the several hundred logs that a local bush gang has spent up to two months felling.

Most of the logs they harvest are rimu, an evergreen tree that takes 500 years to mature, rising 130 feet and yielding up to 20 tons of wood prized for its reddish amber grain. Harvesting rimu by helicopter is the key to Timberlands' goal of sustainable forest management—surgically removing the trees without depleting the source. Out of 432,000-plus acres of New Zealand's indigenous forest, only one tree per hectare (2.4 acres) is harvested every five years.

*Wayne Pratt, a 38-year-old New Zealander, has the traits of a good heli-logging pilot: quick reflexes and a calm temperament.*

*Forestry consultant Ian James makes sure that logging companies don't cut down the wrong trees.*

"There are commonly 150 rimu trees per hectare in lowland Rimu forest, and one taken every five years is a harvesting rate of 0.0013 percent," explains Ian James, a consulting forester for Timberlands. Independent foresters like James select rimu trees for harvest that have reached maturity, trees that would otherwise die. "For every rimu the bush gang cuts, they plant three," adds James.

"That New Zealand is in the vanguard of sustainable forestry could be ascribed to an 'island rationale,' " he continues. "When finite resources start disappearing on islands, it's very noticeable and troubling."

Over the last century, more than 80 percent of New Zealand's indigenous forests has disappeared; consequently, since 1986 the state has been mandating more sustainable forestry practices. Timberlands West Coast complied, and has reduced its harvest of rimu from 50.4 million board-feet in 1994 to 14.28 million board-feet in 1995. As the demand for rimu exceeds its shrinking supply, its price has risen substantially. And even though Timberlands is now harvesting less wood, the company's profits have remained steady.

More than 250 visitors from around the world have visited the Timberlands heli-logging sites in the last two years to glean what they can from the operation. "Less than one percent of the logging that's done worldwide uses helicopters," says Anne Pearson, corporate communications supervisor for Timberlands. And though other logging companies use helicopters outfitted with grapples to remove logs, Timberlands' practice of extracting logs from heavily canopied stretches of forest is somewhat uncommon; conventional heli-loggers often lift logs from cleared patches of land. So far, Timberlands' helicopter harvests have been profitable, and appear to leave the rainforests virtually undisturbed.

Indeed, the only possible way to perform such a low-impact, low-volume harvest over large tracts is with helicopters, since conventional ground-based logging tends to tear the hell out of forests. One of the things that makes conventional logging so destructive is that it requires the building of roads, which bisect mountainsides and cut

*The Mi-8 is powered by two 2,200-horsepower Isotov turbines, which give it the juice to fly at 150 mph and the strength to lift an 11,000-pound log in the jaws of an 800-pound grapple (right).*

across ridges. The roads provide access for skidders and crawlers, heavy equipment used to drag the logs off the mountains. "Ground-based logging compacts subsoils, alters soil hydrology, and often wastes more than 60 percent of the biomass in a forest," says James.

Even though heli-loggers are spared the expense of building miles of roads, theirs is still an expensive operation. It costs Timberlands $5,500 an hour to operate the hard-working Mi-8. The helicopter does, however, generate an average of $24,000 an hour in log production. Another incentive to log by chopper is that the companies that run the sawmills favor helicopter-extracted logs, which are clean of the blade-dulling dirt and stones that embed timber harvested by ground-based logging methods.

Once rimu became such a valuable resource that loggers could harvest less of it and still take home the same money, Timberlands' helicopter contractor chose the Mi-8 over other helicopters in its payload class, such as the Boeing Vertol and the Sikorsky S-61. "Helicopter manufacturers are afraid of these Mils," says Wayne Pratt. "They should be." Because Russia's economy is so sluggish, "you can buy four [Mi-8s] for the price of a [Sikorsky] S-61 or Boeing Vertol," Pratt says. Obviously proud of the helicopter he flies day in and day out in the bush, Pratt continues: "This Mil has 2,500 hours on it and has logged about 5,000 hours of maintenance"—an excellent ratio of 2:1, which is comparable to the maintenance requirements of the Sikorsky S-61 and the Boeing Vertol. In fact, the Mil has "exceeded expectations for low downtime," says Pratt. "We can take it out for a month at a time with a couple of toolboxes and a few spare parts."

The current Mi-8 employed by Timberlands was brought over from New Guinea in 1993 in a somewhat convoluted deal in which a New Zealand company, Heli Harvest Ltd., leases from JSC AERINN, a Russian company, the Mil and its four-man Russian crew—a pilot, flight engineer, and two ground engineers. The ground crew includes Igor Gorbatch, the smiling electronics technician, or spark chaser, and Alexandre Kouzavkov, a powerful, robust man who can coil and load the 200-pound cable into the cargo door unassisted. Like a pumped-up pit crew about to service a race car, Gorbatch and Kouzavkov, spend much of their day waiting for the chopper's hourly stops for fuel.

Anatoli Khraponov, flight engineer and all-around troubleshooter, is the Mil's repairman. He also lends a hand to Gorbatch and Kouzavkov when the

Mil sets down on the refueling pad to take on another 190 gallons of Jet A fuel. (That represents only a fraction of the helicopter's nearly 700-gallon fuel capacity, but carrying so little fuel aboard enables more logs to be carried.) In the windy clamor, the Russians use hand signals to let the driver of the fuel truck know precisely when to start and stop pumping.

Ivan Selivanov, the 38-year-old pilot, is a courtly man who carries a computerized Russian-English language teacher and, with the aid of its little nasal electronic voice, engages everyone he can in conversation. Selivanov sits in the right seat and flies the helo everywhere except at the logging site. That two men fly the Mil, one lifting logs exclusively and the other doing all the commuting, works out gracefully between Pratt and Selivanov. Pratt enjoys freedom from checklist starts, and at the end of the day he walks away from the aircraft while the rotors are still turning. For his part, Selivanov loves flying over some of the world's most dramatic landscapes. At any rate, JSC AERINN, the Russian holding company that leases out the Mils, insists

*Though the log hits the landing area with ground-shuddering force (top), a bushman stands ready to trim its remaining limbs, a task he must finish before the helicopter comes back with another $1,000 load (top).*

*The helo's cockpit is equipped with a computer (above), which keeps a running total of the number and weights of logs lifted.*

that they be accompanied by their own flight crews and engineers.

If any maintenance is due, Selivanov shuts down so Gorbatch and Kouzavkov can go to work. On the ground, the Mi-8 is big and homely, a 1960s Soviet design that was adapted to withstand the rigors of the war in Afghanistan. (This MTV model is equipped with powerful 2,200-horsepower Izotov TV3 turbines, which can operate at higher altitudes.)

"The Soviets weren't too interested in gingerbread, but they knew their bloody workhorses," says Pratt. External fuel tanks distend the Mi-8's body. Exposed rivets emphasize the roughness of its unpolished alloy skin. "Cheap, paint, eh?" says Pratt as he rubs his hand over the fuselage and it comes away Aeroflot-blue. In places the paint has eroded, revealing dull yellow primer. Behind the twin engines, the aft third of the fuselage and most of the tail boom are smudged black by exhaust.

The Heli Harvest/AERINN Mi-8 is not the first of its design to lift logs in New Zealand. That honor goes to an Mi-8 that began its service life as a Cuban troop carrier, flying in tandem with Fidel Castro's personal transport, also an Mi-8. Sometime in the 1980s, Castro gave both helicopters to Nicaragua's President Daniel Ortega, and in 1992 they were purchased by Helica C.A. Ltd., an El Salvadoran subsidiary of a

Canadian firm that had a partnership with New Zealand helicopter companies. Rob Dalley, a Timberlands logging supervisor, dismantled the castoff choppers on the apron of El Salvador's international airport at Comalapa, and somehow fit both of them into a Cuban-registered Ilyushin Il-76 transport jet and brought them to New Zealand. Castro's former flagship was stripped of its lavatory, leather seats, and other finery, then cannibalized for parts so that the other Mi-8 could be reborn as a logger.

One morning in April 1993, on a routine flight to work, it crashed in the foothills east of Hokitika, a town on the South Island's west coast. All that's known with certainty is that the main rotor somehow chopped off the tail boom, flipping the helicopter into a mountainside. The two New Zealand pilots and a young Canadian engineer were killed. The close-knit community of South Island helicopter loggers still grieves the loss, and demurs when asked about details.

Because the cause of the crash remains a mystery, Moscow's Mil design bureau monitored stresses on the current Mi-8 for the first six months of the job, concentrating on its rotors and tail boom. The ship passed all tests, a source of comfort to the members of the flight crew, who spend most of their work day flying outside the "dead man's curve," where the vehicle's low altitude and velocity preclude auto-rotating to a safe landing should a mechanical failure occur. "If we get an engine failure, the other one automatically goes to full power and we can drop the [200-pound cable] instantly," says Pratt. "But at the altitude we operate from, if we get a gearbox failure we're buggered. We'd have the flight characteristics of the log we're carrying."

Pratt doesn't worry about such failures: He trusts the Mil and the Russian crew who maintain it. But ultimately his survival depends on his flying skills.

*The Mi-8 adds another log to the pile every few minutes. At such a prodigious rate, the helicopter's two-man ground crew must refuel hourly. When they're not waiting on the thirsty chopper, Alexandre Kouzavkov (below, left) checks out the log-lifting hardware, while Igor Gorbatch (right) brushes up on his English.*

The job requires an unwavering attention to numerous variables; all day long, Pratt's arms, legs, and eyes are engaged. While keeping the Mil safely in the air, Pratt must also monitor the movements of the dangling grapple, which he does by poking his head into a bubble window that extends over the left side of the helicopter. "I don't daydream up there much," he says with a laugh.

If he did daydream, he might think back to the days of his youth when he used to "jump deer." The wild ungulates that Pratt used to catch are some kind of deer-elk hybrid that attain the size and strength of a yearling quarter horse. With a pilot at the controls of a small helicopter, Pratt would stand on the skids, and, as antlers and a buckskin back came under his perch, he'd jump. He'd grasp the beast's shoulders and rack, dig his heels in like a rodeo cowboy, and bulldog it to the ground. Tied and blindfolded but usually unhurt, the animals were sold to game farms that raised them for their meat and antlers (pur-

portedly an aphrodisiac).

At 38, Pratt is an unimposing presence in the company of the burly young bushmen and stout Russians with whom he works. His simple uniform of olive-green overalls and plain gray cap would easily suit an airport janitor. Under the cap, his eyes reflect amiability and an even temperament. The collar-length hair that falls from the back of the cap may be his only concession to the flamboyance of his deer-jumping days.

Ray Henry, the supervisor of Timberlands' helicopter logging operations, has seen most of New Zealand's logging pilots work conventional heli-logging jobs, in which the chopper lifts the logs from clear-felled tracts. He's also spent time observing American pilots pull logs out of an Oregon rainforest. "The big difference is that the Oregon crews quit in drizzles that didn't impede vision," says Henry. "Wayne will fly as long as he can see and the wind isn't too bad."

Henry regards Pratt as one of the best pilots he has ever seen, but he also appreciates Pratt—and the Russians—for their conviviality with the logging crews on the ground. "It's a big strain, working day after day in the rain and mud," he says, his Maori ancestry evident in his solid stature. "People can get pretty tightly wound up or depressed." With the powerful grace of a rugby forward, he coils a 15-foot steel cable as thick as his thumb into a three-foot ring. His eyes follow Pratt, just across Madman's Creek, inserting the grapple into the broccoli-green hillside. Says Henry: "Wayne's under more strain than anyone, but he's steady and upbeat."

Pratt is up there twisted in the pilot's seat, his head sticking out over the edge while he lowers the cable. He has to land the grapple astride prone logs, which leaves the opening of its jaws only about a foot of clearance on either side. In the instant that the jaws align properly over the log, he lowers the chopper a few feet while activating a solenoid that allows the grapple to close up tightly.

Using a grapple in a thinning operation demands more than the usual skill and concentration required of conventional heli-loggers. Most of them lift logs with the aid of "hookers," workers who stand on the ground in cleared patches that don't obscure the pilot's vision. Conventional logging pilots need only get the end of the cable within about 10 feet of the log; then the hooker attaches the log, which has been noosed with a strop—a thick rope of woven nylon. But in an intact forest, the rotor wash from a hovering chopper could knock limbs and dead trees on to the hooker. Since Heli Harvest's pilots can't use hookers, they're on their own—it's just them and the grapple.


*Working in the bush has its pleasures, including the frequent sighting of wildlife (above), but it can also be stressful. Says Ray Henry, a veteran supervisor of helicopter logging operations (below): "It's a big strain, working day after day in the rain and mud. People can get pretty tightly wound up or depressed."*

Heli Harvest's owner, Grant Biel, a mechanical engineer, is still refining its design with suggestions from Pratt.

What Pratt has learned is that he must lower the grapple quickly. He must time its swing and twist to get it astride the log before the rotor wash bends the forest canopy and understory of younger trees, vines, and brush into an impenetrable swirl of greenery. Some of the native rimu forests are such a jungle that even after three bushmen have spent six weeks cutting down several hundred trees and marking them with pieces of white plastic, Pratt can fly low over the whole place and not see a single log.

When this happens, the bushmen go back into the forest on foot, find safe vantage points, and direct Pratt to the felled trees. The bushmen all carry two-way radios, and—designating the nose of the helicopter as noon—guide Pratt in. The system works, though it has its frustrations. (Fortunately, Timberlands has acquired a dedicated radio frequency so that the expletive-filled utterances of the bush gang trying to guide the helicopter aren't broadcast across the sparsely populated west slopes of the Southern Alps.)

Coupled with the occasionally frustrating nature of a heli-logging operation is the need to improvise: The helicopter crew members weigh logs with a converted cattle scale, which is affixed over a hatch in the Mil's floor. The electronic scale sends a readout to a computer in the cockpit, which tabulates each log and keeps a running total of the weight the crew lifts daily. Pratt says that if a log is overweight, he can usually feel it through the controls, and if the scale verifies the weight as more than five metric tons (11,000 pounds), Pratt aborts the lift. "Even if I were willing, the Russians wouldn't allow it," he says. "To be safe, you have to draw a line and stick to it." As for the

*Rimu is prized for its reddish amber grain (opposite). As the harvest of the towering redwoods becomes more selective, the supply drops, driving up prices.*

bushman who cut the log too heavy, he has to "hump a chainsaw back up those bloody lung-busters and buck off the excess weight or make two logs out of it," explains bushman Chris Heath.

And so it goes, seemingly without interruption. Pratt, the Russians, the landing crew, and the bushmen pile up another $1,000 log about every two minutes in a harvest they hope will rotate sustainably throughout the 500-year growth cycle of the rimu.

After a 50-hour run spanning eight consecutive days of glorious antipodean spring, in which the Mil crew lifted more than 1,600 logs weighing 1.5 million pounds and worth more than a million dollars, a matchbook-size flap of blade tape on the underside of a main rotor blade peeled back. Pratt and Selivanov heard it and made an unscheduled landing. Gorbatch, Kouzavkov, and Khraponov immediately leaned a ladder against the tail boom and wheeled the massive rotor around until they spotted the flaw. Within minutes they had rigged a blue plastic tarp over the blade like a pup tent. Perched on the dirty tail boom and a ladder, they sat under their windproof assembly working with a two-part adhesive and a butane torch, cleaning, gluing, and clamping the flap. Selivanov and his talking computer put the word out on the landing area that the glue had a set-up time of two hours.

The congenial crew of aviators, bushmen, and fuel truck driver set up a vessel to boil water and sate their common love of tea. The bush gang, which so often hunkers down for lunch in the damp cabs of pickup trucks, idled roofless and warm in the sun. Ray Henry passed around a plastic container holding seven substantial crayfish tails, which he had boiled and chilled. Fingers that usually curl around heavy tools cracked the red tails open and went at the rich white flesh.

Lounging on logs and rocks in the shade of a wall of rimu at the landing's edge, everyone ate, drank, and conversed contentedly while the glue set up. The expatriate Russians spoke, as they often do, of home and families, and the Kiwis touched on helicopters, rugby, and election gossip. They too spoke of their families.

By the time their kids reach the age of the bush gang, in 30 years or so, the human population on Earth will have doubled. Finding ways to feed, clothe, and shelter 10 billion people poses an immense challenge. The bushmen and helicopter crew, however, aren't driven by frightening projections of the coming population explosion; they simply love the work. They are sincere in their efforts to learn how to sustain a resource, though they admit to being beginners. "We're not hidebound in this," says Ray Henry. "We think we're logging sustainably. If we aren't, we'll know within 10 or 15 years and keep evolving techniques."

In the shade at the edge of the landing area, several hundred potted rimu seedlings awaited planting. Someone asked Ray Henry how he thinks they'll be harvested 500 years from now. The big logger pondered the idle helicopter and the supply of seedlings. Then he just shrugged and looked down at the crayfish tail in his hand.

COMMENTARY:

# A More Perfect Union

Modern Russia is heir to a rich legacy of space exploration—one with both positive and negative components. On the positive side are decades of hard-won technical space expertise. On the negative side is a "closed society" culture in which space decision-makers have no accountability to the Russian people and do not solicit advice from informed sources outside their closed community. This makes Russia's space effort irrational to outsiders—both foreign space agencies and the Russian people themselves.

The 1990s have not been good years for Russian spaceflight. On the one hand, the technical legacy of Russia's space program has permitted the country to join in building the International Space Station, a cooperative venture with the United States, Europe, Japan, and other world space powers that has potential benefits for all mankind. On the other hand, attitudes born of cold war suspicion and distrust in both Russia and the United States are poisoning this new and promising cooperation.

In the United States, the cold war created an attitude best summed up by the question "What can we wring from our cooperation with Russia?" When U.S. Congressman George E. Brown Jr. was chairman of the influential House Committee on Science, Space, and Technology, the *European Space Report* quoted him in February 1993 as saying, "Now is the time for tremendous opportunities in relations with the Russians because they are hungry and cheap. At the same time, they run world-class scientific and technical centers which can be useful to us."

More recently, at a congressional hearing held last February after economic difficulties delayed the Russians' completion of a key component, the committee's current chairman, James Sensenbrenner, characterized Russia as "an absolutely lousy partner."

In these pronouncements, two aspects stand out. First is the cynical language "hungry" and "lousy," which I see as a pretext for advancing American dictates and abandoning the principles of equality and mutual benefit in space cooperation.

Second, clear to many but ignored by some Russian negotiators is the American desire to put U.S. national interests on a pedestal over all else. What about global issues and the survival of human civilization? And what about Russian national interests? If we are to be long-term cooperative partners, we must learn to accommodate each other's national requirements.

At present, Russia is in the midst of difficult economic and social transformations. The situation is analogous to what you might experience if you are working with a close colleague who is having a difficult time at home. While you should expect your troubled colleague to do his best in his work, you should also bear in mind that other concerns are distracting his attention.

Our mutual dedication to exploring space makes Russia and the United States colleagues. The United States must be open-hearted about the peculiar conditions in Russia. Some NASA money has likely gone astray in Russia as a result of these difficulties and the lack of accountability on the part of our space decision-makers. But continuing cooperation can remedy this situation. Cooperation with the United States will help teach Russians about openness and accountability.

Last December, several non-governmental Russian space organizations conducted a conference in Moscow that sought to address the question "Will the Russian space program survive?" We presented three possible scenarios for the future of Russian spaceflight. In the optimistic scenario, Russia's space program would somehow remain great while undergoing democratization only slowly. This seems unlikely. If the pessimistic scenario unfolds, on the other hand, then Russia, with its great history of achievements in space, will cease to be an independent space power and become a mere contractor to other space powers.

A third, more realistic, middle course is the most desirable. In this scenario, Russia's space program becomes more accountable to the Russian people, more efficient, and more innovative in its approaches, benefiting both

DAVID POVILAITIS

# Grigori Khozin argues that Russia will make a better partner in space if it is treated as a colleague, not a contractor.

Russia and its cooperative partners.

So how do we arrive at this future? In view of Russia's history and present social, economic, and political conditions, the following goals must be met: First, in any Russian involvement in international space cooperation, the principles of equality and mutual benefit must be applied to all partners. Further, Russian space technology must be improved and used more efficiently and Russian space program personnel must receive adequate training. Management methods and organizational structures in the Russian space program must also be improved to increase accountability and the means by which outside organizations can contribute views and ideas; space policy advisors should also be installed at the highest level of the Russian parliament and presidency.

Furthermore, the scientific discoveries, technical innovations, and managerial practices that arise from space-based activity should offer benefits to non-space sectors of the Russian economy. The Russian economy should also benefit by the sale of certain space technical achievements to foreign partners. And space-based activity must include contributions to Russian national security, such as the maintenance of surveillance satellites. Finally, the Russian Space Agency should be completely open about the country's space achievements and long-term strategic plans.

These goals should be viewed in the context of the recent failure of the Russian Mars '96 probe. The loss of the spacecraft shortly after launch last November—to the detriment of more than 20 contributing nations—is traceable in part to the erosion of Russia's space infrastructure. After all, how can engineers produce first-class spacecraft when they are starving?

So how can we encourage the United States to help Russia achieve the desirable middle course? Russian negotiators should make clear that they are aware of the negative views being voiced in the United States and other countries about cooperation with Russia, and should line up other options for cooperation in case their U.S. partners forget the principles of equality.

Last December, Yuri Koptev, director-general of the Russian Space Agency, announced that contracts would be signed this year for extensive cooperation in manned spaceflight with China. Two Chinese flight controllers began training in Russia's Star City last fall. China has a rapidly growing economy and plans to launch its first astronauts using Russian experience and technology in two years.

**In the U.S., the cold war created an attitude best summed up by the question "What can we wring from our cooperation with Russia?"**

One possibility I raised at the December conference is the formation of a Eurasian space organization, which would likely include Russia, China, Japan, and Kazakhstan, and perhaps Australia and India as well. This alternative cooperative arrangement reflects current worldwide trends that see Asia and the Pacific Rim ascendant in economic and technical capabilities.

The reader should understand, however, that I would prefer that the United States succeed in making space cooperation with Russia a mutually beneficial, two-way activity, so that my country need not pursue such alternatives.

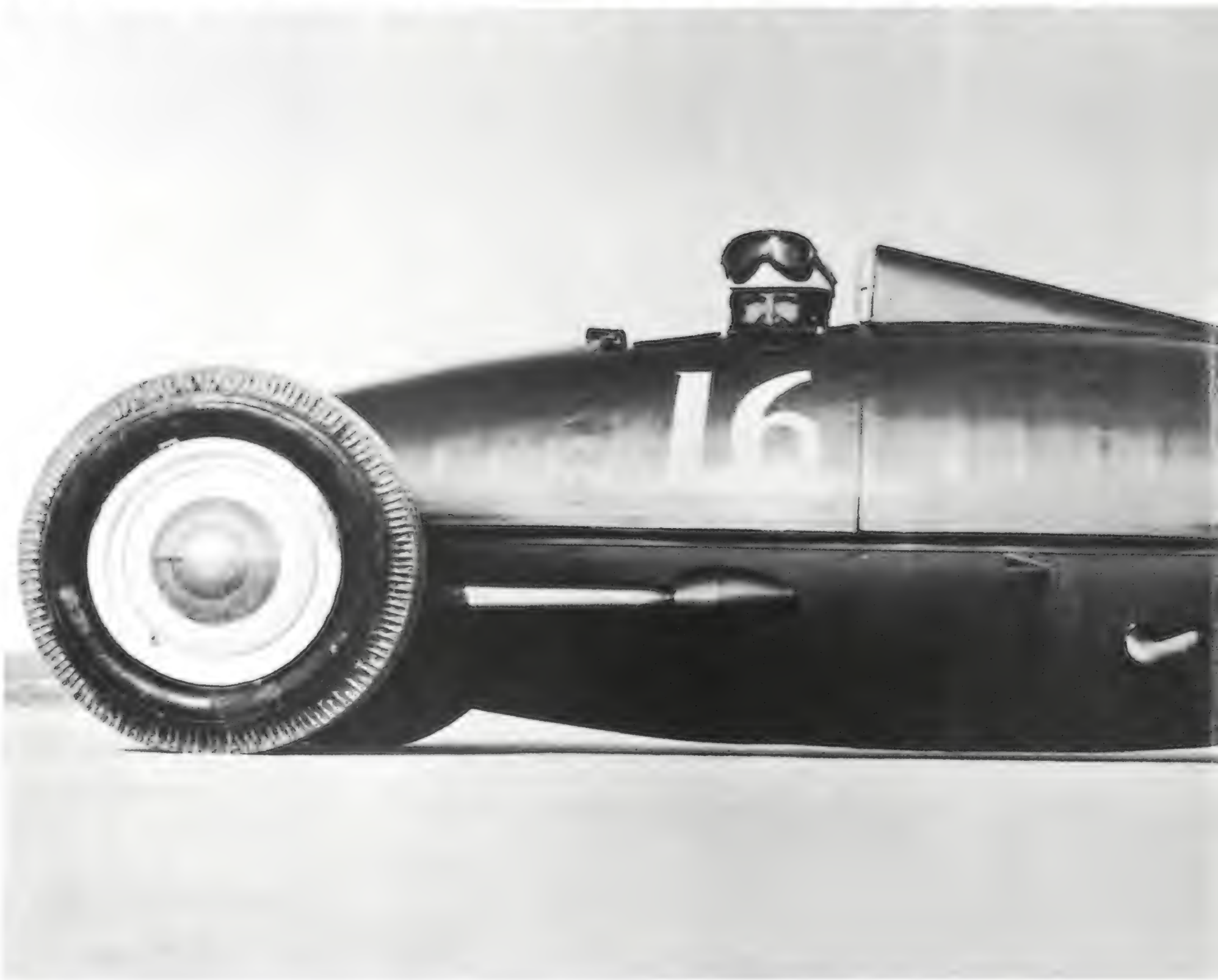
In the course of the cold war, humanity mastered the technology to step over the threshold into space. Now that the cold war is over, all of humanity should be aware of its grave responsibilities and its place in the universe and unite to change philosophies and stereotypes that are not conducive to the progress of civilization as a whole. The experience of space research offers many prescriptions for the future, the main one being that progress on Earth and in space is possible only if it ensures sustainable economic and social development for the entire world.

This goal can be achieved only by the concerted efforts of international political and societal forces in the name of the future. So far, we have focused our efforts on technology. But disregarding the cultural and moral impact of our past and present situation in space exploration is akin to depriving mankind of a worthy future.

I want to conclude by mentioning one more positive legacy of Russian spaceflight. Russians have always held an idealism about humanity moving into space as one. Russia wants to share this idealism, along with its experience, with the United States and other countries so that all humanity can benefit from activities away from our home on Earth. With this future-oriented idealism, which elevates the rights and interests of future generations, perhaps we can grow together beyond the negative attitudes created by the cold war.

The author directs the Global Problems Center at the Diplomatic Academy of the Russian Foreign Ministry in Moscow.

# Tanks, Hot Rods, and Salt



World War II left in its wake precarious peace, Levittown, the Berlin Corridor, the G.I. Bill, Harry Truman, and serious hot-rodding. Hot-rodding?

"Sure," says Pomona, California rod restorer Pete Chapouris. "You take a guy who had some kind of Ford or Chevy that he'd been working on and driving to high school, and you throw him into this big airplane. All of a sudden he looks around and goes, 'Wow, man, that braided stainless steel oil line, that works. And what about this steerin' wheel, this is plenty cool. And look at these neat switches and this bitchin' bucket seat. And these seat belts—man, I could keep from flyin' out of my car.'

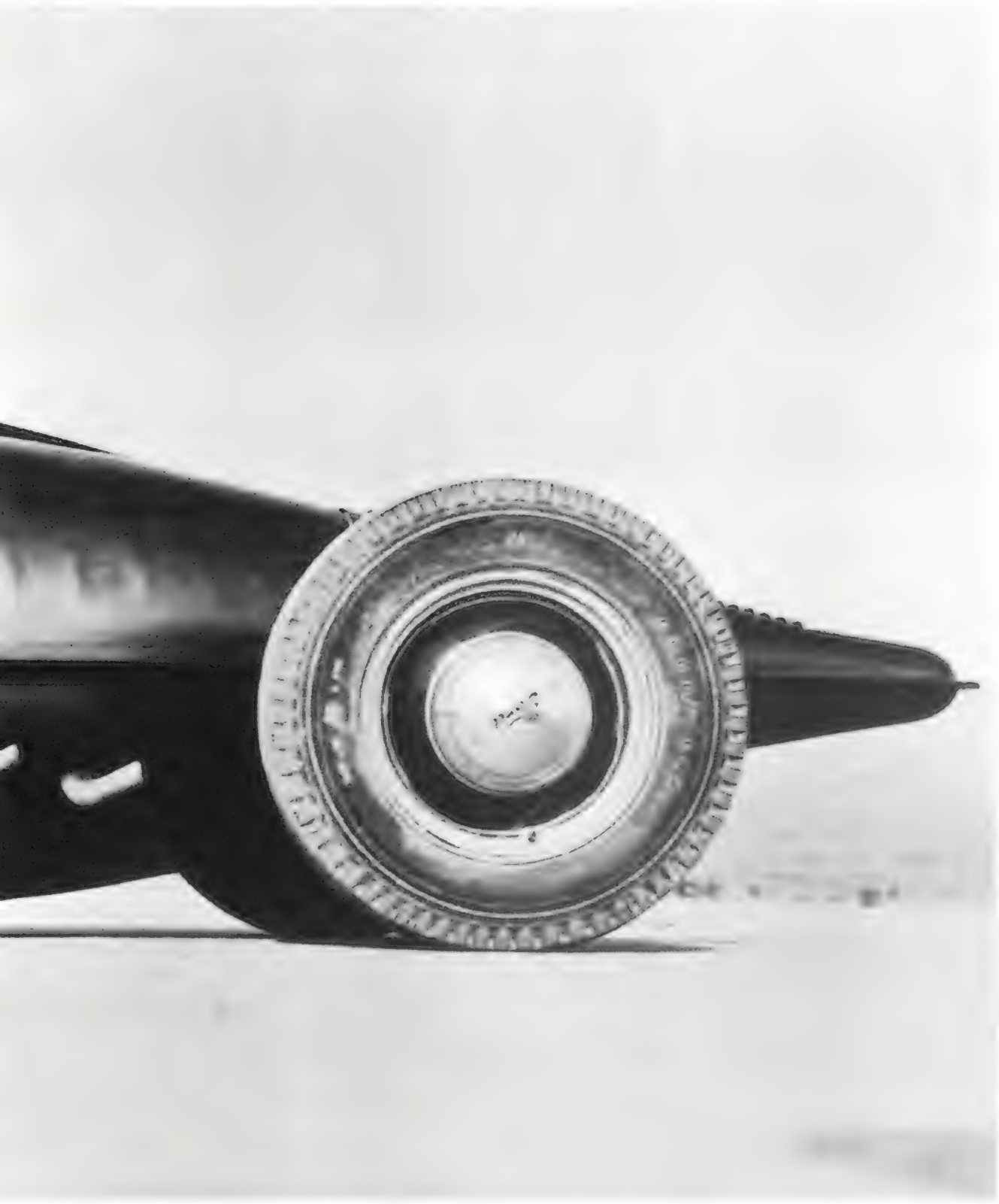
"World War II spawned hot-rod racing just as going to the moon spawned computers," Chapouris points out. "Same sort of technology shift, just in a different time frame. Clevises, jam nuts, Dzuses, Allen-head bolts—you look at the early post-war rods and they're just covered with aircraft stuff."

In fact, some of the cars themselves were aircraft stuff. They were called "belly tank lakesters," invariably shortened to "tanks." A tank was a starkly simple, mid-engine, open-wheel raindrop of a car, a soapbox racer on steroids. It was made by dropping a driver and an engine into a World War II-surplus aircraft drop tank—the disposable, streamlined, aluminum fuel containers carried under the bellies and wings of fighters to supplement their internal tankage.

"Here was something the government had designed to have a low coefficient of drag at 300 mph in flight," says

*How to make a 200-mph race car out of World War II surplus.*

by Stephan Wilkinson



ALL PHOTOGRAPHS FROM THE COLLECTION OF GREG SHARP

*After the war, aircraft drop tanks became part of northern Utah's racing scene. Wally Parks, the founder of the National Hot Rod Association, took a turn around the Bonneville Salt Flats in a tricked-out P-38 drop tank.*

Dennis Varni, who races a tank on the Bonneville Salt Flats in Utah even today—one of three true lakesters still running. "It was the perfect thing to cut a hole in so you could poke your head out and see, put your flathead Ford engine in it, and go. It was affordable racing. The body was already built."

The first tanks were somewhat primitive devices, really little more than a pair of frame rails narrowed to fit inside a belly tank and bolted or welded to a solid 1930s rear axle. Front suspension was minimal. But at a time when "roadsters"—most of them the classic bucket-bodied 1932 Fords—had top speeds of 116 to 126 mph, the stunning reduction in frontal area afforded by the World War II belly tanks immediately kicked speeds up to 150 and 160 mph. Still, the tank drivers wanted more.

How fast would the cars go? Well, in the late 1940s and early '50s, while Mercedes-Benz, Maserati, Alfa-Romeo, and even Indy 500 teams were running fancy overhead-cam engines that powered monster race cars to maybe 150, the kids running on California's dry lakebeds and Utah's salt pans were tickling 200 mph with flathead Ford V8s—an antique engine (introduced in 1932) that resembled nothing so much as two Model A four-cylinders sharing a common crank. And by the 1960s, with the arrival of enormously powerful supercharged Chrysler Hemi engines, one tank had done 292.

Tanks, in fact, were the fastest open-wheel race cars on earth. And in their compact dimensions and "backward" driver-in-front configuration, they presaged the teardrop-shaped, rear-engine European grand prix cars that would revolutionize racing in the early 1960s. This was a coincidence, not the product of either enlightened hot-rod engineering or fat California wallets. "Most of us had no money at all," recalls ex-racer Tom Sparks. "Not only no money but no real facilities or equipment. Oh, we could put a V8 engine in a Model A frame, but that was about the end of our capabilities."

But ingenuity they had in excess. "LA was the phonograph-record headquarters of the country," Sparks says, "and the various companies would cut their records on oversize aluminum master discs. Well, those masters would fit over a standard 16-inch wheel pretty good. I had a friend who worked at Decca, so we'd use them to cover both the inside and outside of the wheel, reduce the drag." (One can only hope they were masters of discarded Johnnie Ray takes and not forever-lost Sinatra sessions.)

A Navy veteran named Bill Burke is entirely responsible for the hankering for tanks. Retired today but still playing with hot rods, including a 1937 Ford and a record-setting Studebaker Avanti, Burke recalls, "I saw a group of wing tanks on a barge, being taken ashore at Guadalcanal, and I thought, *My God, what a beautiful piece of streamlining*


*A twin-boom racer driven by the late Mark Dees reached a sizzling 262 mph at Bonneville.*

*Though short on leg room, the tanks protected drivers with roll bars (below).*

*that is!* I got a tape measure and went aboard and measured one of them. I knew the dimensions of a Ford rear end and the size of an engine block, and I could see they'd fit."

Burke made his first lakester out of a small P-51 auxiliary tank, and following convention, he put the engine in front. "There wasn't enough room to put it in back and still get a seat and your legs in front of it, so I sat upright behind it and stuck out of the tank a long ways. Yeah, it was a helluva windy ride," he laughs, "but it did the job."

After that, Burke switched to 13-foot-long, 315-gallon Lockheed P-38 drop tanks—a streamlined shape exactly three feet in diameter at its fattest point. "You'd laugh at what I used for frame tubing inside those tanks," he says. "I used old Model T rails for the first one, but then I switched to PBY Catalina wing strut tubing for the frame rails. It was clean, strong, good-looking, and pretty good-size."

The first surplus drop tanks were available for as little as $35 or $40 apiece, and hundreds of them were piled in surplus yards. Racing hobbyists weren't the only ones interested in buying them, though. Ranchers split the tanks in half for use as animal watering troughs, and many were also used as houseboat pontoons and advertising display attention-getters.

The tanks consisted of top and bottom halves bolted together along horizontal flanges. The aluminum shells didn't themselves hold the fuel; they contained a seamless rubber bladder. Since the top half was encumbered with the fuel opening and all the hardware necessary to fasten the drop tank to the airplane, standard procedure was to build a car out of two smooth, mirror-image bottom halves.

"You open up an aerodynamics textbook and there it is, the classic teardrop described as the optimum streamline shape," said Mark Dees, a California lawyer, former tank racer, and amateur auto racing historian who died in a traffic accident last December. "Well, that shouldn't be a surprise. Those tanks were designed by Lockheed, and they could open a textbook too."

Nor should it be a surprise that postwar California hot-rodders were attracted to things aeronautical since a number of them were Air Force vets (excluding Navy man Bill Burke). "When you look at the early photographs taken on the dry lakes, there are a lot of guys wearing big sheepskin jackets and leather ballcaps with the bills turned up," Pete Chapouris points out. "Most of them had been in the Air Corps—gunners, mechanics, fliers. Imagine being 19 and flying a P-51 and the next day you're back in Glendale with a major need for speed. You can't afford to buy an airplane, so you go racin'."

Alex Xydias, perhaps the best known of all lakester drivers, was one of them. (In 1952 he booted the *So-Cal Special* to 198.34 mph, faster than any normally aspirated flathead Ford-powered vehicle has ever traveled.) "The Air Force had a great need for mechanics, and most of us who had a chance to volunteer rather than be drafted, we signed up to be airplane mechanics," remembers Xydias. "Gosh, we saw guys from Southern California wherever we went."

Some of these vets, in an attempt to reduce the frontal area of their lakesters even further, used the considerably smaller 165-gallon teardrops intended for P-51s and P-47s. This severely compromised the aerodynamics, however, by putting both the driver and the V8 engine's cylinder heads and carburetors well out into the considerable breeze. Even the full-size tanks were a packaging problem. Says Dennis Varni, whose car is based on a P-38 tank, "In ours, you lay down inside the tank. Your head isn't exposed. You look between your legs through a very narrow, very small windshield that's about four feet in front of you, so it's like looking through a tunnel." What's it like at speed? Varni laughs. "It's a great high," he says. "Better than sex: It lasts longer."

Mark Dees got around the packaging problem by building a twin-boom racer: two tanks connected by the axles. He outfitted one tank with the engine and seated


himself in the other. "It was a fun car to drive," he remembered. "You're sitting in the left boom and you look over to the right and you'd swear that somebody in another tank has driven right up next to you at 260 mph."

"The thing I remember most about driving a tank was not the speed but the incredible racket," muses Xydias, an ex-B-17 flight engineer and top-turret gunner. "You were down inside this echo chamber, and the straight-cut gears in the Halibrand rear end were howling and the engine was just screaming. The salt was never as smooth as it looked, so you were kind of bouncing along, everything making such a racket that it was just unbelievable." Xydias once described it to a friend as "riding in a 55-gallon oil drum with three or four guys running alongside hitting it with baseball bats."

The noisiness of the lakesters wasn't the only drawback. "I would expect all those tanks were pretty horrible to drive, in terms of handling," opines Kirk White, a New Smyrna Beach, Florida dealer of vintage and exotic cars who is in large part responsible for a recent surge of interest in classic hot rods as collector cars and museum pieces. "I suspect it took a great deal of nerve to pilot one of those things at anything approaching 200 mph. Aerodynamically, there was nothing to press them onto the ground the faster they went [as happens with a modern race car]. They were good for the time, but I'll bet that driving one today would terrify the best race driver in the world."

The golden age of the tank peaked with Xydias' spectacular 1952 demonstration of what a nitromethane-fueled, pre-war flathead engine could do. But his 198-mph achievement was soon overshadowed by the beginning of a new era—that of the post-war, overhead-valve V8. These simple but sophisticated engines, particularly the Chrysler Hemi and the ultimately ubiquitous small-block Chevy, stoked America's love affair with the automobile. With such horsepower available, fickle need-for-speed hot-rodders quickly moved to plumb the possibilities of envelope bodies hand-crafted from sheet aluminum—full streamliners—thus eliminating the enormous drag of the open-wheel tanks.

Still, a surprising number of the old tank race cars remain—in one form or another. Not that there were many to begin with: probably no more than 20 that utilized the classic P-38 drop tanks. But they changed owners, engines, and colors so often that for a while they seemed to be everywhere. ("Yeah, but remember, you're talking about dry-lakes racing, a sport that was done by maybe 300 or 400 people total," Dennis Varni points out. "So 20 cars would be a lot.")

*A belly tank driven by four-time Indy 500 champion A.J. Foyt rose to the challenge at a 1955 regional drag-racing meet in San Antonio, Texas. Unfortunately, Foyt jumped the start and was disqualified.*

Today, a war-surplus aircraft belly tank would be snapped up for thousands of dollars by a collector, a warbird enthusiast, or an entrepreneur eager to restore or replicate a classic lakester. "I would say the old tanks are starting to become, not priceless, but certainly up in the $150,000-plus range," says Pete Chapouris, who was hired to restore the *So-Cal Special*, which today sits in the Peterson Automotive Museum in Los Angeles. "The *So-Cal* car, with its history, is going to be worth $200,000 before long."

Indeed, the old cars have been validated with that most quintessentially Californian of honors: Today you can buy replica fiberglass drop tank half shells and build your own tank.

# From 24 miles up the race continues for aviation's most elusive prize.

by Jan DeBlieu

*Photographs by Chad Slattery*

Bob Martin sounded relaxed. Yes, he said, his long-awaited around-the-world balloon flight is set for next winter, with takeoff from Australia. For the first time it looks as if this dream, which will entail piloting a balloon to the very brink of outer space, will come true. Martin was clearly determined, on this morning in late January, not to worry that balloonist Steve Fossett might fly around the world first.

At the moment it was Fossett who held the world's attention. The adventurous commodities broker from Chicago had crossed the Atlantic in his *Solo Spirit* and was closing in on Egypt. Martin's tone didn't fit with what I knew of his deep desire—some would say obsession—to be the first to fly a balloon nonstop around the world. Martin, affable, heavy-set, and rather rumpled, is no wild man, but he has an adventurous soul. "C'mon Bob," I said, "aren't you a little nervous that Fossett will make it all the way around?"

Martin paused. "Well, the guy's got a lot of guts. I can't wish him anything but success." A chuckle. "Yeah, okay, he's got us on the edge of our seats. It would be ideal if he'd get about halfway around the world. And then we could come in next winter and make the full circle."

Four days later, Martin, a light-airplane pilot, helicopter flight instructor, and television news reporter from Albuquerque, New Mexico, got half his wish. Fossett ran out of fuel and was forced to land in India, ending what Martin called "the greatest balloon flight in history"—and setting the stage for a neck-and-neck race around the world next winter.

Barring complications, in late December Martin will take to the sky with well-known balloonists Troy Bradley of Albuquerque and John Wallington of Australia in a craft called the *Dymocks Flyer*, a space capsule tethered to a research balloon made of clear polyethylene and partially inflated with helium. As the helium expands to fill the balloon, they will rise at about a thousand feet a minute, a rate that will gradually slow until they reach the stratosphere. There they will settle in at a cruising altitude of up to 130,000 feet—more than 24 miles. In the process they will set an absolute altitude record and, they hope, stay aloft for the 18 to 22 days it will take to claim ballooning's last grand prize: the first nonstop circumnavigation of the earth.

At least three teams will try to beat them. Unlike the *Dymocks*, the other teams will race west to east in the fast winds of the lower atmosphere (see "The Low Riders," p. 58). They are all using a type of balloon known as a Rozier, which has become the balloon of choice among long-distance competitors. The Rozier has a large helium envelope that rests atop a smaller cell of hot air. When the helium cools down at night and loses buoyancy, the hot air is heated up to maintain altitude.

The participants have likened the contest to the race to fly the first airplane nonstop from New York to Paris. It has much less commercial significance, of course, and less popular appeal. Yet in ballooning circles, the first round-the-world title is being chased with great fervor and a considerable amount of cash.

Five unsuccessful attempts by a Nevada-based team in a complex, double-tiered balloon dubbed *Earthwinds* reportedly cost between $7 and $10 million. The team lost its backing from hotel magnate Barron Hilton and is out of the race. In early 1996 Fossett flew from South Dakota only as far as Nova Scotia before equipment failures forced him to land. That trip cost $300,000. Last January's flight cost another $350,000. Also in January, two teams, one Swiss and one British, sank millions of dollars into flights that had to be aborted after less than a day aloft. Several other teams are honing designs and searching for sponsors, including a group working under the direction of Dick Rutan, the Californian who copiloted the airplane *Voyager* nonstop around the world in 1986.

Rules for the circumnavigation have been set by the Fédération Aéronautique Internationale, an association based in Paris. Participants must fly a minimum of 15,835 miles in a great circle around the earth, crossing all its meridians, and land the craft intact. The

*In a pressurized aluminum gondola, Bob Martin hopes to make the first balloon flight around the world.*

# Thin Air, High Hopes

finish line is the same longitude as the point of takeoff. No monetary prize is being offered. The allure lies simply in the chance to go down in history.

Because balloons travel only as fast as the wind that carries them, a round-the-world trip is likely to take more than two weeks, even for those teams flying in the jet streams, which enable speeds of 100 to more than 200 mph. Yet no one knows if conventional balloon envelopes will be able to withstand the cold and stress of high altitudes during such an extended trip. The current duration record, 146 hours and 54 minutes (just over six days), was set by Fossett on his flight in January.

In that regard, the *Dymocks Flyer* enjoys a particular advantage. The polyethylene balloon that team members will pilot is of a design that has been used by atmospheric researchers since the 1950s. Dozens of such craft are launched each year. These days they rarely carry humans as cargo, as they did between 1956 and 1961, when both the Air Force and Navy sponsored manned balloon flights to the stratosphere. (Navy balloonists Malcolm Ross and Victor Prather used a similar balloon to set the current manned balloon altitude record in the spring of 1961, when they ascended to 113,740 feet.)

The winds of the stratosphere, because they are largely unruffled by earth's terrain and weather fronts, are among the smoothest and most predictable in the world. (They are also among the least studied and understood.) Unlike jet streams, stratospheric winds spread out in wide, smooth flows, like a shallow river that spills across a plain. They circle the globe in gentle, undulating waves.

In summer the stratospheric winds flow from east to west, the opposite of the prevailing surface winds that girdle most of the earth. Sometime in spring the easterly winds lighten, and for several weeks the flow of air is fickle. In winter the winds reverse and blow strongly and less predictably from the west. By launching during the Australian summer, the team will take advantage of the milder summer winds.

Since the 1970s, balloons of the size and design of the *Dymocks Flyer* have circumnavigated the earth a handful of times carrying scientific payloads. "There's no doubt in my mind that these balloons can stay up long enough to go around the world," says Steven Shope, the chief engineer for the project. "With the other balloon designs, there are questions about whether the envelopes will get too brittle in the cold, and whether they can withstand the wind shears in the jet streams."

The *Dymocks* balloon looks surprisingly like a huge sandwich bag. Nine hundred feet in height and 450 feet in diameter, it carries a gondola strung

## *The Low Riders*

It wasn't Per Lindstrand's idea to launch on January 7. In fact, he warned British tycoon and adventurer Richard Branson just before their 200-foot-high *Virgin Challenger* floated up into the Moroccan sky that morning that they were rushing things. But Lindstrand, an experienced professional balloonist, told Branson, "It's your call. It's your money," and off they went.

They should have waited.

Three ballooning teams tried last winter to round the world by riding the high-speed winds of the jet stream, or, more accurately, jet *streams*. The streams form where polar and tropical air masses come together and squeeze the air between them into narrow, fast-moving currents. Every now and then—maybe two or three times a winter—the currents link up to form a continuous river around the earth. This is the event the balloonists watch for.

The previous winter the jet streams never did link together and Branson didn't get the chance even to try. This winter he jumped at the first good chance for a global jet stream that came along, which meant rushing the pre-launch checkout and fighting to inflate their million-cubic-foot balloon in a stiff ground wind.

*Three up, three down: The Swiss lasted only hours, American Steve Fossett flew to India, and the British took the scenic route.*

The balloon was at 30,000 feet and closing in on the jet stream when the bad news came over the radio: In the rush, the harried ground crews had left safety catches on the large propane tanks ringing the outside of the capsule. Because the flight team would have to drop these tanks quickly in an emergency, they made the decision to descend so that one of them could climb outside to release the catches.

The balloon was descending on the lee side of the Atlas mountains when it was slammed downward by a vicious rotor wind. The rotor drove them straight toward the desert floor at the rate of 15 feet per second (see "In the Grip of a Whirlind," July 1996). "That rotor wanted us," recalls Lindstrand. "It was a real death dance." Lindstrand and Branson immediately started tossing ballast, while the third crewman, Alex Ritchie, heroically worked to free the safety catches so the propane tanks could be dropped.

NICOLAS LE CORRE/GAMMA LIAISON, INC.

With the ballast and tanks went any chance of circling the globe. Even more galling to Lindstrand was that their competitor, U.S. millionaire Steve Fossett, *did* wait a week, and caught "the most perfect global launch weather I've seen in the last 10 years."

But Fossett had his own problems. Unlike the other two balloons that launched last winter, his *Solo Spirit* has no pressurized cabin, meaning that his only protection from the cold and thin air was a heater, an oxygen mask, and a Plexiglas bubble over his open gondola to keep the warmth in. This strategy is appealingly low-tech, but the physical demands on the pilot make other

like a spiderling below it. For launch it is stretched out on the ground and filled with 170,000 cubic feet of helium—a proportionally small amount—while the gondola dangles some distance away, held by a crane. Once released, the balloon rises until the density of the helium inside the envelope is the same as the density of the atmosphere outside. It passes through the troposphere, where temperatures grow increasingly cold with altitude, and then through the tropopause and into the stratosphere. It achieves its unusual altitude because the huge volume of the envelope, nearly 40 million cubic feet, allows the helium to continue expanding. Conventional gas balloons hold 35,000 cubic feet of helium.

Balloons that fly in the troposphere lose lift in the cool of night and descend into increasingly warmer air, which accelerates their fall. To keep them up, pilots must either drop ballast or warm the helium with burners. But in the stratosphere, where temperatures grow warmer with altitude, balloons can sustain a cruising altitude of up to 130,000 feet in the daytime. At night, as temperatures cool, they fall to as low as 80,000 feet.

Above the *Dymocks Flyer* will be only the thinnest wisps of the earth's outer atmosphere. The air will be ringingly clear, the sky a velvety purple, even at noon. Below, the surface of the earth will curve away, shrouded in clouds.

Drifting west from its launch site in Alice Springs, the balloon will cross the Indian Ocean, Africa, and the southern Atlantic at about the same latitude as the Tropic of Capricorn. With luck the craft will pass directly over the storm-lashed region of the Andes—the kind of terrain that other balloons, flying within reach of thunderstorms, will studiously avoid. There the pilots will watch for upward-flashing lightning, bursts of light known as red sprites and blue jets that are associated with thunderstorms but are otherwise largely a mystery. Traveling at the relatively slow speed of 60 to 115 mph, crew members should be able to make the most detailed observations and photographs of these phenomena ever recorded.

Elsewhere the crew will take gaseous samples of the ozone layer, and special gauges will measure cosmic radiation levels. Throughout the flight the crew members will record thoughts and emotions for a study on the psychological effects of close confinement. No American astronaut has ever spent longer than 14 days in quarters the size of the *Dymocks* capsule.

Conducting research is so important a part of the mission to Martin that he says his team will make the trip even if someone completes a circumnavigation first. In fact, his inspiration for the adventure came from science.

balloonists shake their heads. Fossett, says Lindstrand, is "almost superhuman."

With its open gondola, the *Solo Spirit* isn't built to fly in the core of the jet stream. But Fossett flirted with the high-speed winds at its edge, reaching as high as 26,300 feet as he zipped across the Atlantic at 120 mph. Fossett had to reduce altitude now and then to stay warm and avoid the occasional storm system—which meant that he used propane fuel (brought to heat the air in his Rozier system) at a much higher than expected rate.

Fossett's project manager Bo Kemper says he doesn't know whether the balloon could have made it around the world, given the fuel it took to cross the Atlantic. But Libyan President Muammar Qaddafi made it a moot point. Fossett used additional fuel to stay low and slow while he waited for Qaddafi's permission to fly over his country. (Branson had gotten *his* permission by persuading Jordan's King Hussein, a pilot and ballooning enthusiast, to phone Qaddafi.) By the time Fossett cleared Libya, any hopes of a round-the-world attempt were gone. So he set his sights on breaking the duration record for a balloon flight—six days and 16 minutes—set by Troy Bradley and Richard Abruzzo in 1992. When he crossed into India, the *Solo Spirit* was ambling along at only 10 mph, and at only 700 feet altitude, just trying to stay aloft. To win the record, Fossett fought his way through thunderstorms, later e-mailing his crew in Chicago: "FIRST LINE OF TSMS [thunderstorms] DIDN'T KILL ME."

JOHN MOORE/AP WIDE WORLD

Barely two hours after breaking the record, he set down in a mustard field in northwest India, where a crowd of 500 or so thronged around the slightly unnerved pilot. Some of the locals told news reporters they had first thought it was the Hindu monkey god, coming down from the heavens.

It was a different kind of fuel problem that foiled this year's third attempt. Only a few hours after their January 12 launch, a team sponsored by the Swiss watchmaker Breitling were nearly overwhelmed by fumes from kerosene leaking into their cabin. They had cleverly swapped propane for kerosene to save the weight of heavy pressurized tanks. But a 50-cent hose clip failed, leaving the two pilots ankle-deep in kerosene. They ditched in the Mediterranean, never even getting the chance to test their round-the-world skills.

THIERRY BOCCON-GIBOD/GAMMA LIAISON, INC.

The Breitling team has grand plans for next winter, however. In fact, there are two things all the low-riders agree on: They're all definitely going to try again. And they're all going to win.

*—Tony Reichhardt*

In 1989 Martin wrote a news story about Robert Golden, a scientist at New Mexico State University who was using helium balloons to scan the upper atmosphere for cosmic rays and antimatter. Martin was fascinated with Golden's project. "I'm kind of an amateur scientist," he says, "and Bob's work really caught my interest.

"I knew that the around-the-world title was up for grabs, and it occurred to me that this might be a way to do it. I talked a little about it with Bob, but I didn't say much else about it to anyone else. I wanted to make sure the idea was sound."

In 1992 Martin mentioned his round-the-world dream to Bradley, a professional balloon pilot who had just set an endurance record of a little over six days. Martin told Bradley that if they could build an insulated, pressurized gondola (a tall order), they could sail above the weather in a balloon system that was known to be reliable.

"My first thought was: If it's such a great idea, why isn't anybody else doing it?" Bradley recalls. "But Bob's a friend, so I called a few people about it. I told 'em, 'There's this nut out here who wants to fly around the world in the stratosphere.' " A meteorologist Bradley trusted told him the idea was sound. A veteran balloon engineer was even more encouraging. "He said, 'That's the concept I've been preaching for years. If I had the money I'd do it myself.' " Bradley signed on.

The two men named their project Odyssey and began looking for sponsors. Martin designed an eight-foot-wide cylindrical gondola. He consulted closely with Bob Golden, who envisioned Odyssey as a kind of poor man's satellite that might have enduring use for research. An Albuquerque oil tank manufacturer agreed to fabricate the aluminum gondola shell. Other companies chipped in computer equipment, solar panels, and radios.

The launch was set for July 1995. But that January Golden was diagnosed with cancer. He died in April, and the team postponed takeoff for a year. "He was our chief engineer, and we just couldn't do it that soon without him," Martin says.

For the next year and a half Odyssey failed to attract a major sponsor. The team depended on piecemeal contributions from a host of companies, from Lockheed Martin and the National Geographic Society to a chain of Albuquerque dry cleaning stores owned by Bradley's in-laws. As late as February 1996 Martin still believed he could raise the last of the money needed to launch Odyssey that summer: $50,000 for liability insurance, $140,000 for the balloon, $50,000 for the helium. The gondola was being built; vacuum chamber tests had been arranged. The project had more than $1 million worth of equipment and life support systems in hand. But that spring Bradley and Steve Shope told Martin they did not feel comfortable launching so soon. "We could have kept to Bob's original budget if everything goes exactly as planned," Bradley says. "But rescue from the middle of the Pacific is very expensive. We've got to take our time and be careful. I'm very much in favor of living through the mission."

It seemed Odyssey might never fly. Then in June the pilots received word from Dymocks Booksellers, a chain with 93 stores in Australia and New Zealand, that $500,000 might be available if they added an Australian pilot to the flight crew. As part of the deal, the name of the craft was changed and the launch site was moved from New Mexico to Alice Springs, Australia.

Nearly overnight the project was transformed from an independent, low-budget operation staffed entirely by volunteers to an amply financed corporate effort. Australian John Wallington, a national champion balloonist, was named

*Research balloons, delicate as hankies and expandable to 450 feet in width, can take off in only mild conditions.*

NATIONAL SCIENTIFIC BALLOON FACILITY

*Sabri Sansoy, secretary-treasurer and structural analyst of the* Dymocks Flyer *team, created a computer model of the craft for analysis. Chief engineer Steven Shope (below) has experience with GPS navigation systems for high-altitude military balloons.*

the third crew member. And Martin and Bradley moved several steps closer to fulfilling their dream.

"The things that worry me about this project are the mundane," Steve Shope says. "Can we keep the temperature controlled in the capsule? Can we launch it without breaking the solar panels on top?"

Our conversation is punctuated by loud blasts from the propane burner that is keeping Shope's art-spangled hot-air balloon aloft. We are 1,500 feet above west Albuquerque, floating in an urban haze. Below us is a dull patchwork of chemical storage buildings. To the east, the blocky Sandia Mountains hide the ascending sun. The best view is up, to where a nylon bag decorated with stars and swaths of color surrounds a globe of fire-warmed air.

The wicker basket creaks as the balloon rises and encounters a faster flow of air. "What I do is work my way up until I find some wind that I like," Shope says. "If you feel breeze on your face, it means we've hit a different wind layer and the balloon hasn't quite caught up with the flow." Indeed, I am surprised by how smooth the ride is, how dreamlike. This is not high adventure. "Wait till we land," Shope says.

While Martin is the driving force behind the *Dymocks Flyer*, Shope, a physicist who runs an Albuquerque engineering firm, is the point man on safety. Bradley has sworn not to get into the gondola until Shope gives his approval.

The propane burner blasts again; we float in a placid sea of air. Below, a jackrabbit hops across a dull pink field; from up here, it's the size of an ant. How different it would be to fly in a metal cocoon, insulated from the killing cold of space. At night the *Dymocks Flyer* will encounter temperatures as low as minus 150 degrees Fahrenheit, yet in the daytime the sun's rays could warm the capsule to lethal levels. To compensate, the gondola will be wrapped in a layer of foam and painted a shade of white that reflects the maximum amount of heat. The gondola's air processing unit will pass the air through a heat exchanger using liquid nitrogen to cool it. The team is considering a backup solid state cooling system as well. They will also simulate the heat and pressure conditions in ground tests.

"We'll be putting the capsule through tests in a vacuum chamber," Shope says, "and we'll be able to adjust for temperature fluctuations then. We're going over everything in it—everything—with a lot of care. The balloon itself I'm not worried about. They've launched hundreds of balloons like this."

"See that field down there?" he asks a minute later. "That's where we'll land. Hold on and keep your weight low." And we come down with the precision of a small plane as jackrabbits scatter beneath us. The basket bounces three times as we crouch, laughing, then it tips and rights, and the gorgeous balloon billows above.

A short time later I enter a warehouse at EG&G, an aerospace contractor that is building the *Dymocks* gondola's interior for free. I expect to find something high-tech, but what greets me is a cold aluminum shell, shiny, unfinished, and very much like an oil tank tipped on its end. "You can see we've got a way to go," laughs Sabri Sansoy, a dark, friendly young man who serves as the team's main structural engineer.

The gondola reminds me of a flying saucer, though it is boxy instead of streamlined. "We know the structure can withstand a 12-G shock, as long as all the welds connecting the seams hold," Sansoy says. "That's the stress it'll be under if the pilots have to abort the flight and open the parachute that's attached to the gondola. There'll be a five-second freefall, then it'll feel like they've hit a brick wall."

I climb inside. The interior is dark, echoing, and cold as a cave. When I stand in the center and open my arms wide, my hands come within 18 inches of the walls. The ceiling, not even six feet high, gives me a shiver of claustrophobia. Three men, plus supplies and equipment, for nearly three weeks.

The following day, flying home at 31,000 feet, 500 miles an hour, I watch the terrain beneath me, the brown crust crinkled into mesas and mountains, the houses glinting like silver beads. The earth seems fantastic and remote. I try to imagine being four times higher in a craft that flies silently and moves so slowly the earth below seems almost stationary.

"Three years ago I thought this was a one-year project," Bob Martin sighs. "But it's still intriguing to me. It's

*With the* Dymocks *flight, Troy Bradley could reclaim the record he set in 1992 with a six-day journey across the Atlantic. Below: Polyethylene for the envelope is 0.8 millimeter thick. Opposite: Sansoy talks over fabrication issues with EG&G's Tom Ramrath at the company's Albuquerque warehouse.*

like building a model airplane on the biggest scale you can imagine."

It is two months later, and we are back at EG&G, seated in a mockup of the gondola—which, with its cheery white interior, three wide seats, and elevated bunk, is surprisingly comfortable. The chairs are positioned against the walls, leaving an open space in the middle of the floor. Beside each is a desk outfitted with a computer terminal and various buttons: one position for balloon controls that enable the pilot to vent helium to descend or drop ballast to rise, one for communications and navigation equipment, one for monitoring life support systems and the scientific payload.

Through a porthole I see the real gondola, still empty and unpainted. It awaits installation of improved hatches and the solar panels, donated by MEER Instruments of San Diego, that will be the only power source for the capsule's communication and navigation systems, computer terminals, interior lighting—everything. This work will be done at a satellite-test hangar at the Air Force's Phillips Laboratory outside Albuquerque. Until last summer the construction of the craft was being overseen by volunteers with no experience in building vehicles for space. Then one day Martin was contacted by an official at Phillips who wanted to know if the balloon might carry some scientific equipment for the lab as part of its payload. In exchange, engineers at the facility would offer their expertise in building the gondola. "The Air Force needs more cost-effective ways of trying out new space technology," Martin says. "We can test certain kinds of equipment in the upper atmosphere for a lot less money than they'd have to spend on a space shuttle flight.

"Safety-wise, I think we would have been fine going with our original plan," he adds, "but it is nice to have the extra level of expertise."

In addition to getting in top physical shape, the crewmen must travel to NASA's Johnson Space Center in Houston to learn how to use the pressurized flightsuits the center has donated. In return for the suits, the crew will measure cosmic radiation levels at different altitudes for Johnson investigators.

The balloonists will suit up for the ascent and landing and in the event of an emergency. The rest of the time the bulky white spacesuits and helmets will stay in storage. The gondola will carry backup life support systems that would give them at least an hour to put on their suits and personal parachutes and bail out if necessary. But, Martin adds, "we're not flying a proven system. So until we go through a day or so in the capsule, we'll keep the suits on." And with good reason. Should catastrophe strike—should a weld fail, say, and a window blow out—the low pressure would cause the crew members' blood to boil within eight seconds.

"Over there is where we'll keep the cameras from Los Alamos National Laboratory," says Martin, pointing to an alcove under the bunk. Interested in the upward-flashing lightning that the pilots expect to see over the Andes, Los Alamos is training them to photograph it and also to operate detectors for gamma rays and radio waves. In return, the Los Alamos laboratory has donated computer equipment, window materials, and a small amount of cash. This is typical of arrangements Martin has made. "We've used a barter system wherever possible," Martin says. "It works better for everyone."

The *Dymocks Flyer* crew hopes to take off from a balloon launch facility in Alice Springs on December 28, Martin says, "plus or minus a week. We've got to wait for the right conditions. You don't want to have the jet stream flowing right over the launch site. With a balloon of this height, there would be way too much wind shear as we go up."

Aloft, the pilots will have little control over their craft. All they will be able to do is release helium from a vent in the top to descend—which should not be necessary until it's time to land—or drop ballast to climb. The danger of an unplanned descent will be greatest if the *Dymocks* encounters a heavy cloud

GENE BURTON

cover at night that shields the upper atmosphere from the earth's reflected heat. Even this won't be a problem—the balloon would descend to perhaps 80,000 feet—unless the cloud cover coincides with a monster thunderstorm.

"They are rare, but it is possible that a thunderstorm could break through the tropopause to reach 70,000 feet," Martin says. "We could get sucked into the storm. We would certainly have to release the gondola from the balloon. It's also possible that the gondola's parachute couldn't survive" the punishing cycle of updrafts and downdrafts in such thunderstorms.

Martin believes that the amount of ballast the crew will carry—a ton of glass beads or metal shot—would get them through two such encounters.

And then of course there is the problem of landing.

Once the pilots vent enough helium to start down, the speed of the balloon will double as it enters the troposphere and encounters layers of warming air. "We'll go from being a buoyant bubble to being a rock," Martin says. To slow the descent, the pilots may have to discard excess weight through a garbage chute. Batteries, water, radios—all are candidates for disposal. Martin has even offered to parachute out. "There are many well-known stories in the balloon community about people who dropped everything overboard and landed with just the shirts on their backs," he says.

They also don't want to land too lightly and risk being dragged—and tumbled in the process—by what would turn into a 900-foot spinnaker. "We want to stick it on the ground," says Martin.

"We're going to try to find someplace very remote to land," he adds. In his mind's eye, Martin envisions a big crowd of people waiting for their return and worries that somebody could get hurt.

But that is jumping the gun. There still are supplies to be purchased, training sessions to attend, a gondola to transport to Australia....

We climb out of the mockup, and Martin retrieves a sample of the balloon material from his car. It is as thin and clear as a Baggie. I run my hand down the side of the cold aluminum gondola, and hope for the hundredth time that Martin, Bradley, and Wallington survive their jaunt—and make it all the way around the world—in this homemade spaceship.

Dymocks Flyer *launch preparations will look just like those undertaken for a research balloon in Antarctica (minus the snow). The crew will wait in the gondola, suspended from a crane, for the 45 minutes it takes to inflate the envelope, 600 feet away.*

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ART INSTITUTE OF CHICAGO

# >SIGHTINGS<

The Art Institute of Chicago has assembled a traveling exhibit titled "Building for Air Travel: Architecture and Design for Commercial Aviation," which highlights the architectural aesthetics of the Air Age, from the symmetry in aircraft construction to the structural grace of air traffic control towers. Portions of the exhibit are currently on display at San Francisco International Airport's main terminal and the Museum of Flight in Seattle, Washington.

"Airports, airplane interiors, and aircraft assembly and maintenance buildings are among the most important forms of architecture and design in our century," writes Art Institute director James Wood in the accompanying catalogue, which contains period photos and essays on the interplay of air travel and architecture.

Of the 1991 photo of United Airlines' Terminal One at Chicago's O'Hare International (left), airline pilot Wood Lockhart writes that the terminal "provides easy access to over forty aircraft, which when parked at the gate seem almost to be extensions of the architecture."

In a 1929 night view of the terminal at Fairfax Airport in Kansas City, Kansas (above), a Ford Trimotor loiters, an appropriate coach for the travelers who descended from the Art Deco castle that Charles Smith designed for the terminal. Landscape architect Ernest Heminghaus created an accompanying bold landscape that served as a navigation aid.

CHICAGO HISTORICAL SOCIETY, HEDRICH-BLESSING COLLECTION

The Boeing 377 Stratocruiser under construction in the mid-1940s is as much a sculpture as it is a machine (right), and as with many machines, the skeleton and internal workings prove more of a work of art than the finished product. The 377 was one of the first post-war airliners, originally built as a military transport. Its "luxurious lower-deck lounge…enhanced the feeling of spaciousness," writes curator John Zukowsky.

The terminal that opened in 1956 at Lambert St. Louis International Airport (left) was supremely light and airy, its arches suggesting flight. The terminal at Berlin-Tempelhof airport, erected in the late 1920s (below), on the other hand, typifies Bauhaus minimalism. "The street facade of the long, slightly curved, flat-roofed building is especially impressive," writes architectural history professor Wolfgang Voigt. "Its three-story brick front was divided quite simply from corner to corner with continuous horizontal bands of windows.

"The symmetrical scheme of hangar-terminal-hangar…was later adopted at many other airports, because it satisfied an organic ideal that an airfield be circular: it was as though the arriving airplanes were received by the buildings with open arms."

BOEING HISTORICAL ARCHIVE

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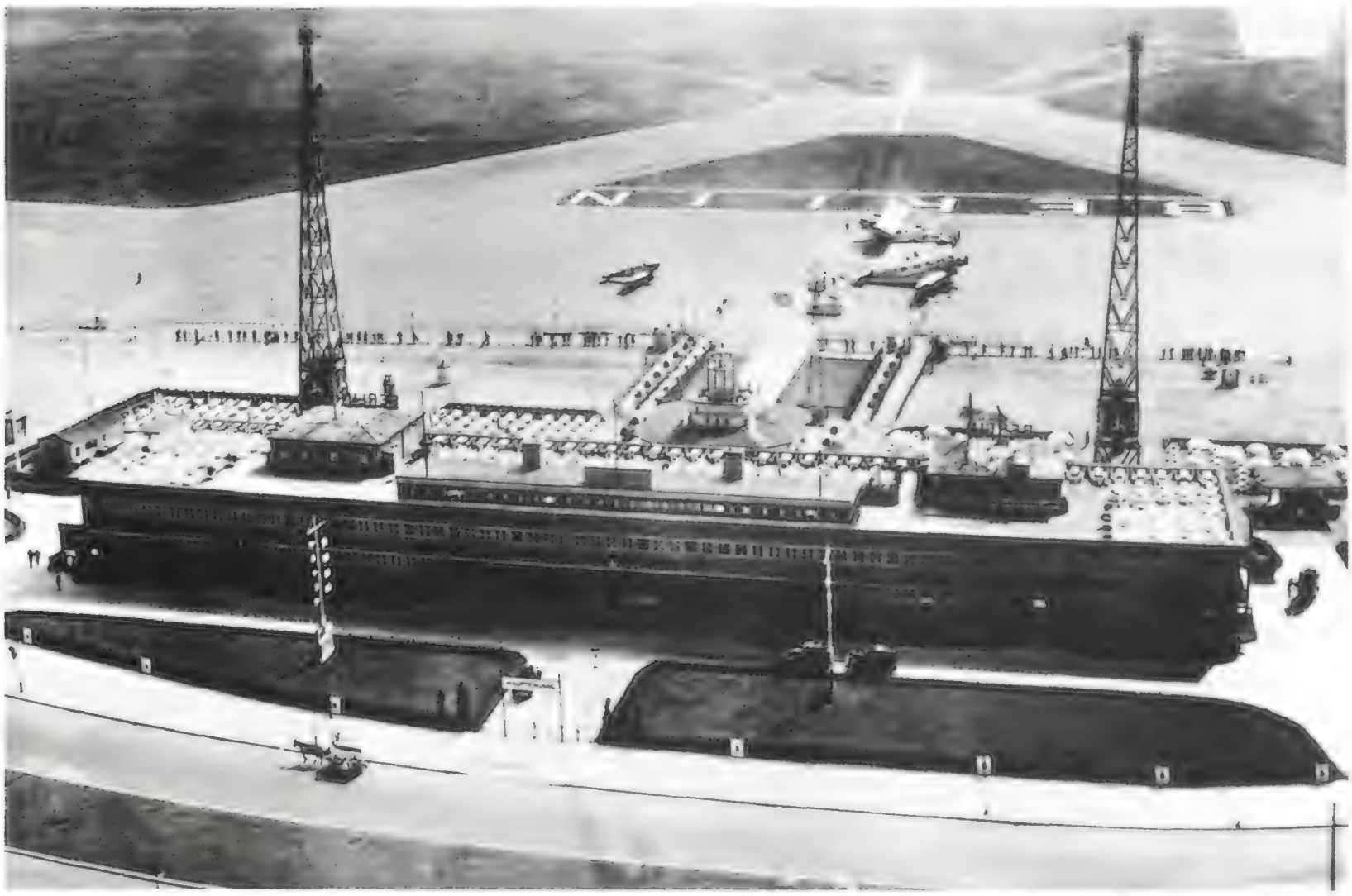
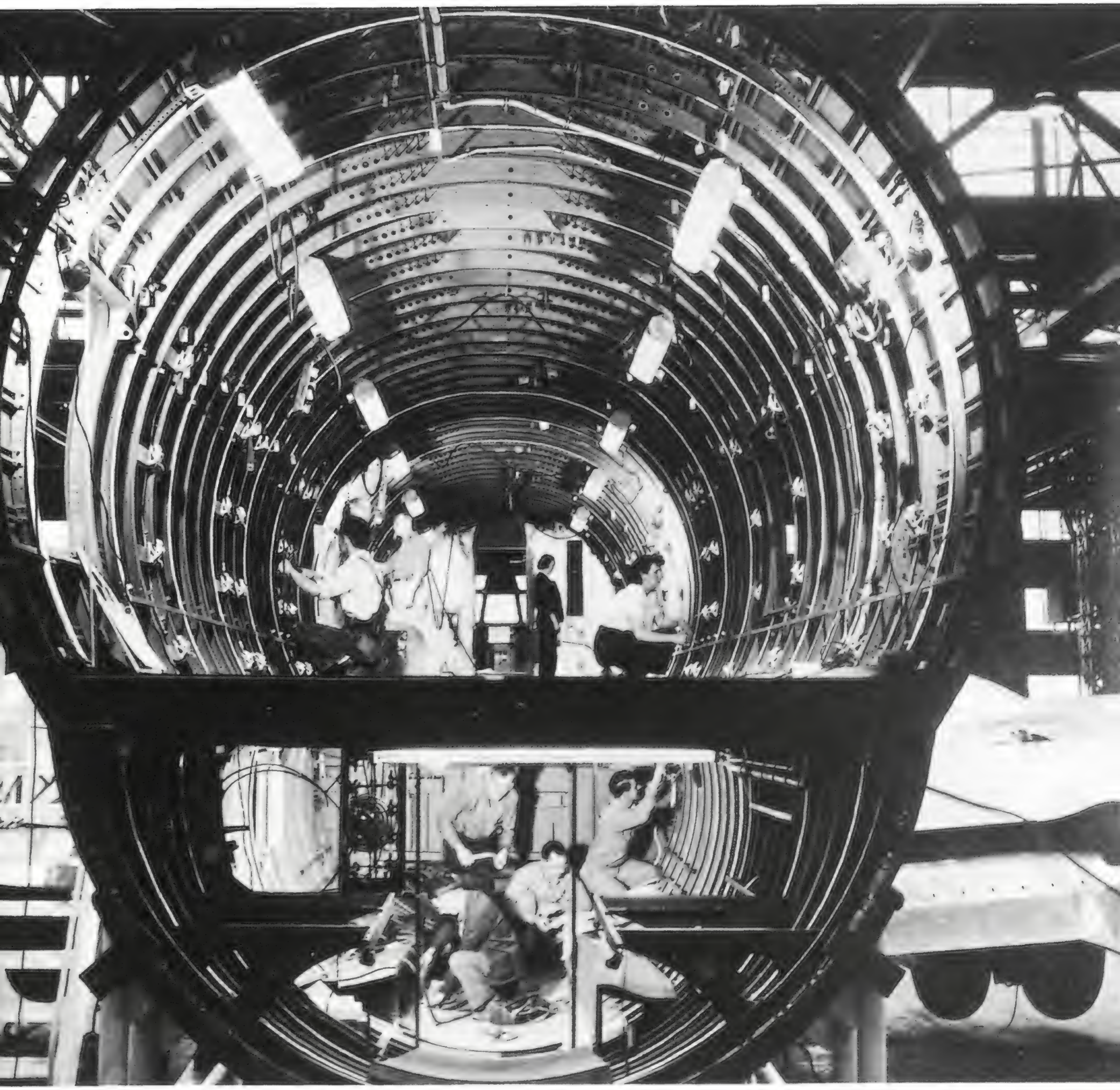




# Fabulous Failures


NASM

**Back to the Drawing Board: Aircraft That Flew But Never Took Off** *by Bill Gunston. Motorbooks, 1996. 168 pp., b&w photos, $29.95 (hardcover).*

Luckily for them, most of the designers represented by the machines in this book are dead and thus won't have to read the pitiless critiques of their work by one of England's finest and most prolific writers. From the Royal Aircraft Factory BE.2 ("The BE.2e...was just as lethal as its predecessors") to the RSRA X-wing ("it would not be quite right to describe the X-wing as a failure, merely as something which turned out to be more complex than it had first appeared"), author Bill Gunston leaves no turkey unbroiled.

One trait that many of the failures share is immensity, a fatal condition to which no air-faring nation seems immune. The allure of the giant transport capable of moving whole armies is like some virus that pops up repeatedly, and past failures seldom inoculate future designers against a repeat affliction.

Perhaps more remarkable is the endurance of pernicious handling qualities (as in the Douglas X-3, above); this was especially true in the face of equally persistent test pilot rejection of the same. The Brewster SB2A Buccaneer/Bermuda ("endemic poor stability, especially in roll and yaw, compounded in some conditions by rudder reversal") was replicated 1,052 times on the assembly lines and went straight to scrap. Blackburn presented its Firebrand, a "torpedo fighter" that looked like a Hawker Sea Fury on steroids and came to symbolize backroom politics at its worst (said one senior officer, "...the flying business is as dirty as horse racing"). Pilots who dared to criticize the airplane were taken to the woodshed, and the airplane, despite its record, was delivered to Britain's Fleet Air Arm in 1945 and placed in service.

Though most of these mistakes were made in wartime, Gunston takes a merciless look at his country's practice of mixing government with the marketplace, thereby protecting the development of bad ideas. The handsome but inept Avro Tudor makes the list as an example of marry-your-cousin airliner development in postwar Britain, where the Ministry of Aircraft Production ordered the airplane into production on behalf of British Overseas Airlines Corporation, which did not know any better and accepted it despite a transatlantic load of only 12 passengers.

Computers have taken much of the sting out of aircraft development today, but this brief volume is still cautionary. And, of course, reading along while Gunston licks his chops in anticipation of the next victim is just good fun.

*—George C. Larson is the editor of* Air & Space/Smithsonian.

**Blankets of Fire: U.S. Bombers over Japan During World War II** *by Kenneth P. Werrell. Smithsonian Institution Press, 1996. 350 pp., b&w photos, $39.95 (hardcover).*

This book is a powerful argument in support of those who believe that where airpower is concerned, serious history is best written by those with both academic training in history and a knowledge of their subject "from the inside out."

Kenneth Werrell was an Air Force WB-50 pilot before he became a professional historian. The Boeing WB-50, a bomber modified for weather reconnaissance, was essentially an improved B-29, which had been the Allies' primary weapon in the devastating conventional and nuclear attacks on Japan during World War II. Werrell's Air Force experience is evident throughout his account of B-29 operations in the Pacific, but *Blankets of Fire* is no apologia for the firebombing of Japan's cities. Instead, it's a richly detailed, exhaustively researched, and eminently readable attempt to answer the big questions about the strategic bombing of Japan: How did an air force that began the war committed to daylight, high-altitude, precision bombing end up dropping bombs on cities and civilians? And, after all was said and done, how much did the bombing contribute to the defeat of our


enemies in the Pacific?

In pursuit of answers to those and related questions, Werrell provides three chapters on the conceptual and technological background to the B-29 campaigns, then six chapters on the campaigns themselves. Equally important, for a work relentlessly based on primary sources, are the 50 pages of source notes, the statistical appendix, and the six-page "bibliographical essay"; the latter, coupled with Werrell's insights into the realities faced by the aircrews, sets this book well apart from both revisionist and buff history.

Werrell shows that the key strategic goal of U.S. doctrine was attacking bottleneck targets, whose loss would so cripple Japan that it could not continue the war. He argues that the absence of such targets, along with Japanese climatic conditions and the bombers' performance limitations, led to the adoption, early in 1945, of area bombing. "Although it is widely believed that [then-Major General Curtis] LeMay was the force behind the firebombing," Werrell writes, "the pressure to firebomb Japan was present before he arrived on the scene. An Army Air Force report in mid-January 1945 summed up the reasons for the switch to area bombing: the failure of precision bombing, the vulnerability of Japanese cities to fire, and the dispersed Japanese cottage industries."

Werrell concludes that the ensuing campaign demonstrated that the B-29 truly was a revolutionary weapon that not only decisively damaged the Japanese will to fight but also changed the nature of warfare. However, he also argues that "the bombing had no significant effect on the Japanese economy, since the factories it destroyed were already in decline or idle because of a lack of materials." That lack, he contends, was the result of the U.S. naval blockade and submarine war on Japanese shipping, which, combined with the usually unheralded B-29 mining of Japanese waters, strangled the Japanese economy before the B-29s burned what was left.

Though some will strongly disagree with Werrell's conclusions, and though his book is marred by many minor editing problems, he succeeds in his "attempt by an academic to apply scholarly standards to an important and neglected aspect of the history of World War II," providing both additional details and context to our understanding of the B-29 campaigns and the close of the war with Japan. The word that came to my mind to describe *Blankets of Fire* was "balanced." In this context, can it be coincidence that balance is a quality valued by every pilot—if not every historian?

*—Steven L. Thompson is a contributing editor of* Air & Space/Smithsonian.

**The American Aerospace Industry** *by Roger Bilstein. Twayne/Simon & Schuster, 1996. 268 pp., b&w photos, $28.95 (hardcover).*

Arriving just before the announced mega-merger of Boeing and McDonnell Douglas, Roger Bilstein's history of one of the most important industries in the United States could not have come at a better time. It will become a standard reference work, taking its place next to *The Jet Makers*, *The Sporty Game*, and *Wide Body* as books we can't live without.

Despite the breadth of the book, the author varies his pace, and when he occasionally pauses at a particularly savory epic like the Sidewinder missile story, you get the feeling he has another book in him on that subject alone. If there is anything frustrating about reading this volume, it's the constant feeling that Bilstein is bursting to tell us more but just doesn't have enough room.


In the book's acknowledgements, Bilstein tips his hat to numerous historians and colleagues, including many at the National Air and Space Museum (where he spent time as a research collaborator and Lindbergh Professor), but the book is no mere review of the literature. Pay special attention to the sections on astronautics, general aviation, and global expansion and, finally, contraction. Once you've read this insightful analysis, the Boeing deal seems only natural.

*—George C. Larson is the editor of* Air & Space/Smithsonian.

**JV44—The Galland Circus** *by Robert Forsyth. Classic Publications, 1996. 356 pp., b&w photos and color illustrations, $85.00 (hardcover).*

Robert Forsyth's *JV44—The Galland Circus* is a fascinating book, and one that aviation history enthusiasts will be happy to own. Its central theme is the story of *Generalleutnant* Adolf Galland's last Luftwaffe command, *Jagdverband* 44, an independent unit of the revolutionary Messerschmitt 262 fighters that operated in southern Germany and Austria during the last few weeks of World War II. However, there is much more to this book than that. Part one (the first five chapters) sets the scene for the appearance of JV44 by reminding readers of the mounting difficulties facing the Luftwaffe's crisis of command in 1944-1945. Part two, making up some two-thirds of the text, deals with the origins and brief life of JV44.

The book includes an introduction written by Galland himself before his death in 1996 and a foreword by Walter Krupinski, a premier Luftwaffe pilot who served with Galland in JV44. Both men praise the author's eye for detail and the

## On the Web

**The Apollo Lunar Surface Journal** *(http://venus.hq.nasa.gov/office/pao/History/alsj)*

For those who still can't get enough of the Apollo program, even after a spate of recent books, a Hollywood blockbuster, and a coming HBO mini-series produced by Tom Hanks, one medium may prove the most satisfying of all: the World Wide Web. Eric Jones, a space writer and historian from Los Alamos, New Mexico, has spent eight years carefully editing and annotating the voluminous transcripts from the six lunar landing missions. Originally he had intended to publish a book, but be thankful he didn't. His labor of love, *The Apollo Lunar Surface Journal* has all the scholarly weight of a clothbound text from a university press, but the multimedia links make it even better. And it's free to anyone with an Internet account.

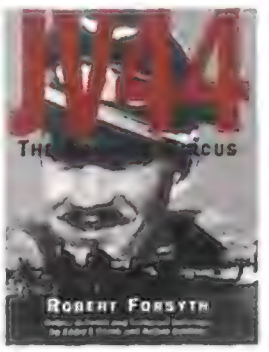
Jones interviewed 10 of the 12 moonwalkers, and their comments and remembrances are sprinkled generously throughout the hundreds of pages of transcripts of TV and radio conversations between the astronauts and ground control. When the jargon starts flying, as it frequently does, these annotations are invaluable. The *Journal* also includes links to audio and video clips, photocopies of the astronauts' checklists and mission timelines, maps of their journeys on the lunar surface, and lots of photos with helpful captions. The raw transcripts are often dry and technical—histories like Andrew Chaikin's 1994 *A Man on the Moon* are a much better read—but for Apollo devotees, this is the mother lode.

*—Tony Reichhardt is a contributing editor of* Air & Space/Smithsonian.

accuracy of the information presented. Since Galland and Krupinski are heavily quoted and their views are strongly represented throughout the book, their opinions may not be entirely dispassionate, but, impartial or not, the story that results is extraordinary. Galland's deteriorating relationship with Hermann Goering, his dangerous fall from favor and dismissal from high command, Hitler's intervention to prevent his disgrace, his "exile" to form and command an independent jet fighter unit—this is all gripping stuff.

The chapters covering JV44's operations are equally rewarding, with good descriptions detailing both the superior qualities and considerable problems of the Me 262. The pilots of JV44 are liberally quoted, which adds to the liveliness of the text. The book is generously illustrated too, with many photographs from private collections never before published.

But the book is not without flaws. Occasionally the text appears to have been so sharply edited as to lose precision. The slips and omissions are generally minor but irritating. Among the more obvious is one paragraph that appears to have been compressed until it suggests a link between the fall of Aachen to U.S. troops and the suicide of Erwin Rommel. Five hundred bombers are said to have "hit" Berlin on March 4, 1944, in the first Eighth Air Force raid on the German capital; in fact, less than half that number were aimed at Berlin that day, and bad weather reduced the attacking force to only 30 B-17s. One photograph is identified as showing an Me 209, the aircraft that helped to delay production of the Me 262, but actually shows an earlier and unrelated Messerschmitt that confusingly carried the same root designation. Letters written in German are reproduced with no explanatory captions, and the index is disappointingly sparse. Readers will find other oddities, including a quote that suggests the Me 262's rudder was controlled by the stick and the ailerons by the rudder bar.




Perhaps more seriously, though the author interviewed Galland and his surviving pilots, he did not quote those who disagreed with Galland's views. The men of JV44 thereby appear as heroic Luftwaffe figures, while others, like Dietrich Peltz and Hajo Herrmann, appear almost as villains. Since both Peltz and Herrmann are alive and talkative, however, it would have been useful to ask them for their side of the story.

Warts and all, Forsyth's *JV44* is a worthwhile addition to an aviation library.

*—Air Vice Marshall Ron Dick is a contributing editor of* Air & Space/Smithsonian.

**Jane's All the World's Aircraft 1996–1997.** *Jane's Information Group, 1996. 838 pp., $335 (hardcover).*

This comprehensive directory has been a revered institution since Fred T. Jane produced the first version in 1909. Over the years it has become almost indispensable to the serious aviation professional. The amount of information in the 800 pages of text is phenomenal. For the Boeing 767 alone, there are three pages of text, tables, and photos listing the characteristics and performance of 15 different airframe-engine combinations. The 753 pages of aircraft listings are followed by sections on lighter-than-air craft, air-launched missiles, and "aero-engines," plus a 38-page index. But there's even more, including a "How to Use This Book" section, a six-page foreword, first flights in the previous year, and a selected official fleet list, detailing the number of aircraft, by type and engine, in each airliner's fleet, the number of these leased rather than owned, and the number on order and on option.

But this year I will not be buying the latest edition of *Jane's*. Simply put, I will not pay substantially more for substantially less. The price this year is $60 more than the already breathtaking $275 I paid last year. And valuable information that has been in every edition since 1910-1911 has been left out of the volume this year.

The section on aero-engines, which numbered 83 pages last year, has been reduced to a nine-page table summarizing "vital statistics of power plants mentioned in the main body of this book." Similar information is listed in tables for piston, turboprop, and turboshaft engines. By comparison, the description last year for the Rolls-Royce RB211 series alone ran for more than a page, not including the Rolls-Royce 535 derivative of the RB211.

But what if you need the comprehensive engine information no longer contained in Jane's *Aircraft*? The publishers come to your rescue with the newly published Jane's *Aero-Engines*, a "400-plus page reference binder service" with two updates in the first year, all for $595. In the second year, three updates will cost $515.

*—Sam Smith is a commercially licensed pilot and an amateur aviation historian.*

# CALENDAR

**April 4–13**
Airshow '97: International Exhibition of General and Commercial Aviation and Airports. Buenos Aires, Argentina, 54-1-328-0478.

**April 20**
Open Cockpit Sunday. New England Air Museum, Bradley International Airport, Windsor Locks, CT (860) 623-3305.

**April 22–26**
Reunion of Pilot Training Class 52-A. Las Vegas, NV, (352) 596-8464.

**April 26 & 27**
Kitefest. River Oaks County Park, Kalamazoo, MI, (616) 383-8778.

**May 3 & 4**
Shell Air & Sea Show: A Salute to the U.S. Military. Performers include the U.S. Air Force Thunderbirds and the U.S. Navy Leapfrogs parachute team. Fort Lauderdale, FL, (954) 527-5600, ext. 88.

**May 7–11**
Reunion of the 446th Bomb Group of the Eighth Air Force (World War II, England, 1943–45). Menger Hotel, San Antonio, TX, (817) 457-5715.

**May 9–12**
Kitty Hawk Kites Reunion and Hang Gliding Spectacular. Jockey's Ridge State Park, Nags Head, NC, (800) 334-4777.

**May 10 & 11**
P-51 Mustang Flying Weekend. Planes of Fame East Air Museum, Eden Prairie, MN, (612) 941-7820.

**May 16 & 17**
Northern California Experimental Aircraft Association Fly-In. Corning Municipal Airport, Corning, CA, (916) 824-0644.

**May 17 & 18**
Warbirds Over Hickory Fly-In: Armed Forces Weekend. Sponsored by the Sabre Society of North Carolina. Hickory Regional Airport, Hickory, NC, (704) 437-0541.

**May 22–25**
Reunion of the 73rd Bomb Wing Association. Little America Hotel, Salt Lake City, UT. For information and registration forms, write: 73rd Bomb Wing Association, 706 Starcrest, New Braunfels, TX 78130.

**May 23–25**
West Coast Antique Fly-In & Airshow: "Quest for Speed—Air Racing Through

## CALENDAR

the Ages." This year's event features racing aircraft from the 1930s to the 1990s. All proceeds benefit the California Antique Aircraft Museum in San Martin, California. Watsonville Airport, CA, (408) 496-9559.

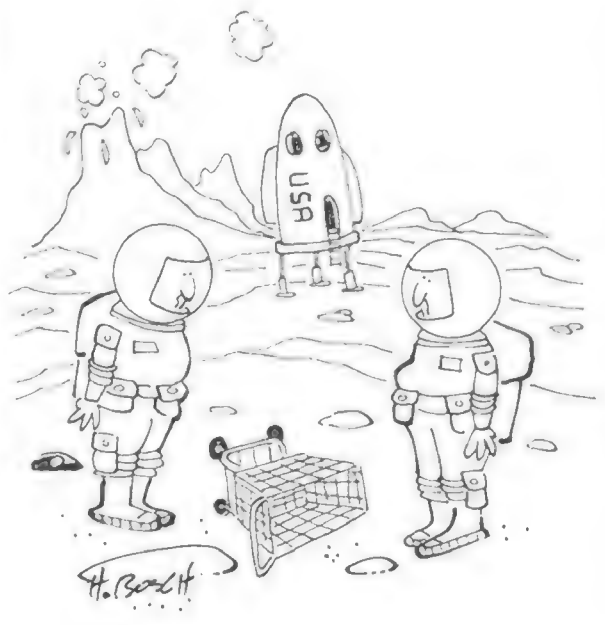
**May 24 & 25**
World's Smallest Airshow. Featuring ultralight demonstrations and competitions. Brian Ranch Airport, Llano, CA, (805) 261-3216.

**May 24–26**
Memorial Weekend Salute to Veterans. Most of the museum's World War II aircraft will fly between 9 a.m. and 5 p.m. daily. Planes of Fame East Air Museum, Eden Prairie, MN, (612) 941-7820.

**May 29–June 1**
"Aluminum Overcast," walk-throughs and flights in a B-17 bomber for people joining the B-17 Historical Society. Former B-17 crew members will share their experiences flying the World War II bomber. Winchester Airport, VA, (301) 248-5394.

**May 29–June 8**
Adirondack Airshow. Sponsored by the Glens Falls Rotary Club. This year's show features aerobatic flying by Patty Wagstaff and the Canadian Snowbirds. Warren County Airport, Glens Falls, NY, (518) 798-2082.

*Organizations wishing to have events published in Calendar should submit them four months in advance to Calendar,* Air & Space/Smithsonian, *901 D St. SW, 10th Floor, Washington, DC 20024. Events will be listed as space allows.*




## CREDITS

**Odorless, Colorless, Blameless.** Following two tours with the U.S. Navy, Richard Van Treuren has worked as a NASA contractor on the space shuttle team for the past 19 years. When not flipping switches in the shuttles, he writes for the publications *Buoyant Flight*, *Aerostation*, and *Gasbag*.

**The Invisible Men.** Bill Sweetman writes about military matters and aerospace, with special focus on stealth technologies. His previous contribution to *Air & Space/Smithsonian* was "Bear Arms" (Oct./Nov. 1994).

Further reading: *Skunk Works*, Ben Rich and Leo Janos, Little Brown, 1994.

*Radar and Laser Cross Section Engineering*, D. Jenn, American Institute of Aeronautics and Astronautics, 1995.

*Stealth Technology: The Art of Black Magic*, J. Jones, Tab, 1989.

*Stealth Bomber*, Bill Sweetman, Motorbooks, 1989.

*Lockheed F-117 Stealth Fighter*, Jay Miller, Aerofax, 1991.

*America's Stealth Fighters and Bombers*, James C. Goodall, Motorbooks, 1992.

**Collision Course.** Dominick A. Pisano is a curator for the National Air and Space Museum's aeronautics department. He wrote "The Crash That Killed Knute Rockne," which appeared in the Dec. 1991/Jan. 1992 issue.

Further reading: *The Golden Age of Air Racing*, S.H. Schmid and Truman C. Weaver, Experimental Aircraft Association Air Museum Foundation, 1963.

*Unlimited Air Racers: The Complete History of Unlimited Class Air Racing, 1946 Thompson Trophy to 1991 Reno Gold*, Don Berliner, Motorbooks International, 1992.

**"Gentlemen, You Have a Race."** David Peters, a Venice, California-based artist and airplane buff, lives near the left turn pattern of Santa Monica's Clover Field, an airport commonly frequented by restored World War II aircraft. While at work in his studio, he often hears the distinctive sound of an old Merlin or Allison engine firing up, and he can't resist going outside to watch the vintage fighter take off and fly out of sight. Peters is also a serious collector of toys, model airplanes, paint-by-number paintings, Shriner memorabilia, and bowling balls (he has 150). And though his large studio is full, he's "still acquiring."

**Pieces of the Rock.** Charles Petit is a science writer on the staff of the *San Francisco Chronicle*.

Further reading: "Search For Past Life on Mars: Possible Relic Biogenic Activity in Martian Meteorite ALH84001," D.S. McKay et al., *Science*, August 16, 1996.

Steve McCracken, a carbon-based life-form, works in Washington, D.C., producing illustrations on silicon-based equipment.

**Plausible Denial.** Susan Katz Keating was part of the aircraft restoration team for the Travis Air Force Base branch of the Air Force Museum. She is now a freelance writer specializing in military topics. In 1994 the American War Library named her book, *Prisoners of Hope: Exploiting the POW/MIA Myth in America*, the Best Book on the Vietnam War.

Freelance illustrator Paul Salmon has created artwork for the Smithsonian Institution, NBC television, National Geographic, Time-Life Books, and the Kennedy Space Center. One of his most recent works, entitled "Supersonic Flight 1947," will be featured on a U.S. postage stamp to be released in October.

**Natural Selection.** Tom Harpole worked 12 years in the Pacific northwest as a logger. During the countless hours he spent walking behind the business end of a draft horse, he always thought heli-logging was a better idea.

Freelance photographer Geoffrey Clifford was a combat helicopter pilot during the Vietnam war.

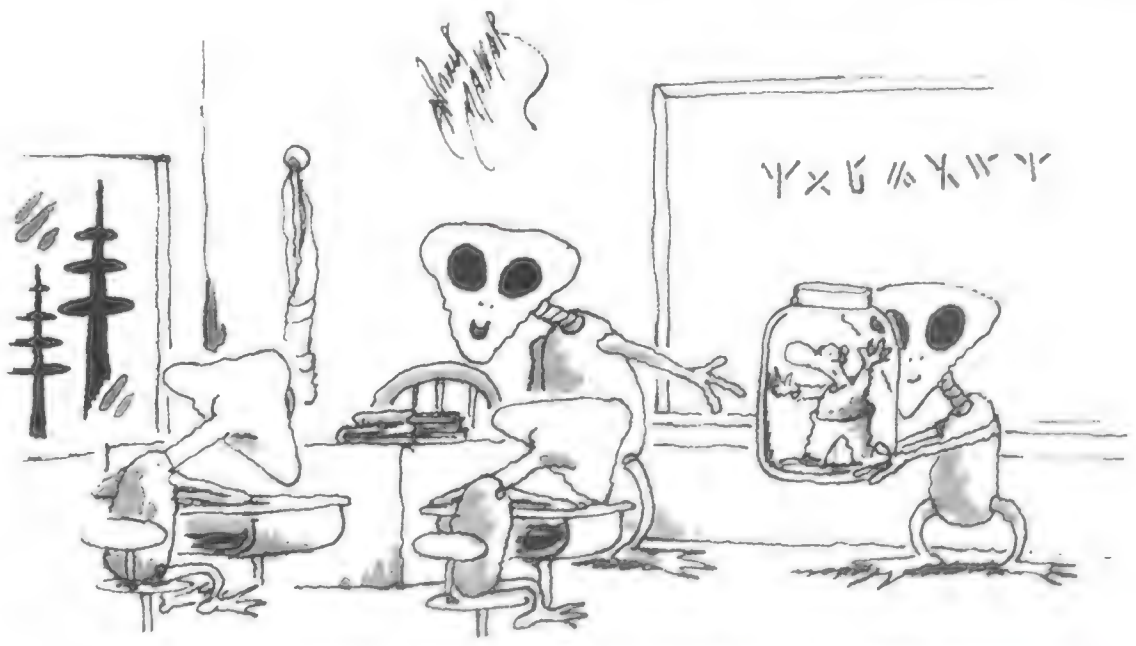
**Tanks, Hot Rods, and Salt.** Private pilot and freelance writer Stephan Wilkinson specializes in writing about automobiles and aviation.

**Thin Air, High Hopes.** Jan DeBlieu lives on the Outer Banks of North Carolina. She is currently at work on a book for Houghton Mifflin about wind and its effects on the natural world and peoples' lives.

Chad Slattery is a Los Angeles-based photographer who specializes in aerospace subjects.

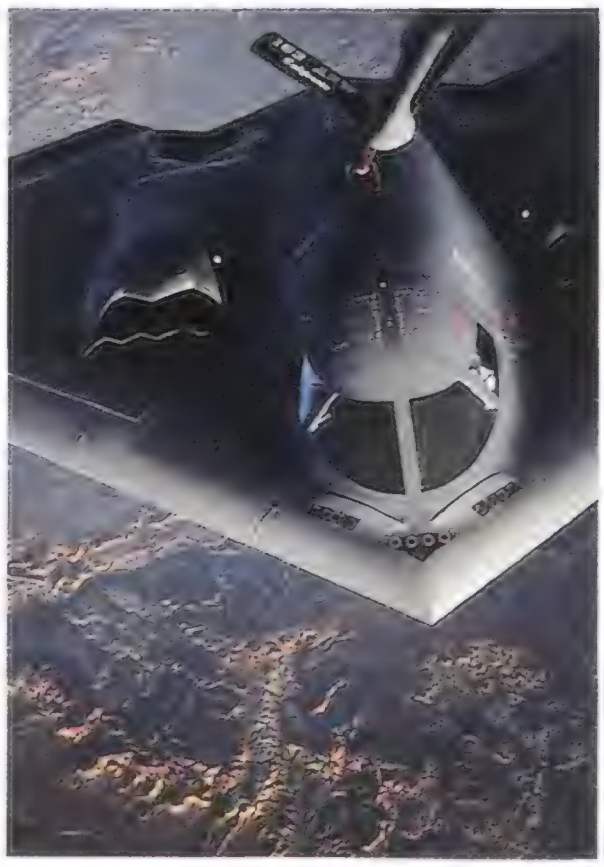
**The Low Riders.** Tony Reichhardt is a contributing editor of *Air & Space*.

**Chapel of the Thunder Gods.** Steven Knipp is a Hong Kong-based correspondent for the *Asia Times*. He also writes for *Newsweek*, the *International Herald Tribune*, and the *Wall Street Journal*.



*"Now it's Ozzor's turn to tell us where he went on this summer vacation."*

## ON THE WEB SITE



TED CARLSON/CHECK SIX

# THE B-2 FROM ANY VIEW

Different views of stealthy aircraft are said to look like entirely different airplanes. See for yourself. The model of the B-2 stealth bomber that now resides at *Air & Space/Smithsonian*'s Web site can be manipulated with a click of your mouse to display the airplane from all angles. Visit the site and learn more about the big bomber's design and flight characteristics. (www.airspacemag.com/supp/AM97/stealth.html)

# MEET Burt Rutan

What inspires Burt Rutan, founder of Scaled Composites, Inc., to create carbon-fiber composite aircraft like the famous *Voyager*, *Pond Racer*, and *Long-EZ*? The inventive designer, who became a pilot at age 16, talks with Associate Editor Diane Tedeschi about how his career got started and the computer-assisted design work he does today. (www.airspacemag.com/TWD/rutan.html)

JAMES SUGAR/BLACK STAR

## FORECAST

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***Short Stay in Hanoi***
The first Jolly Green Giant rescue in North Vietnam.

***Fields and Streams***
Space physicists have found a way to show us the solar particles swarming through the magnetic fields of our planetary neighborhood.

***The Rights to Flight***
How history settled the legal battle between the Wrights and Glenn Curtiss.

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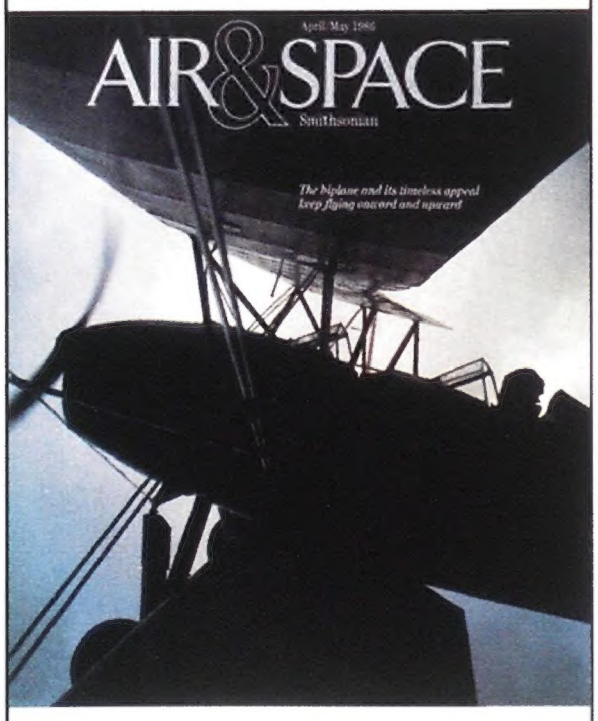


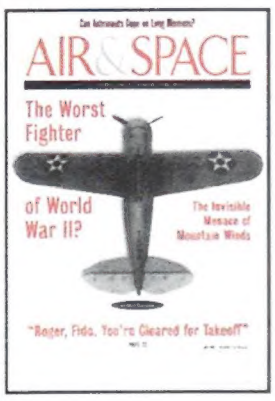


**June/July 1996.**
Bad, bad Brewster Buffalo (left), months-long space missions, killer mountain waves, Pluto's portrait, minesweeping helicopters, broken space tether, air smugglers, and more.


**August/September 1996.**
Police helicopters (left), Falco birthday party, splendors from Hubble, Mustang designers, U.S. aerobatic team, NASA's New Millennium, and more.


**December 1996/ January 1997.**
Saturn V restoration (left), car engines for airplanes, how spacecraft dock, escape from Vietnam to Thailand, birth of the ICBM, helicopter olympics, and more.

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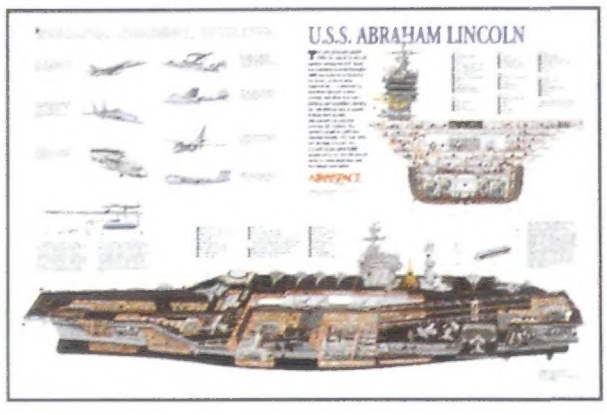


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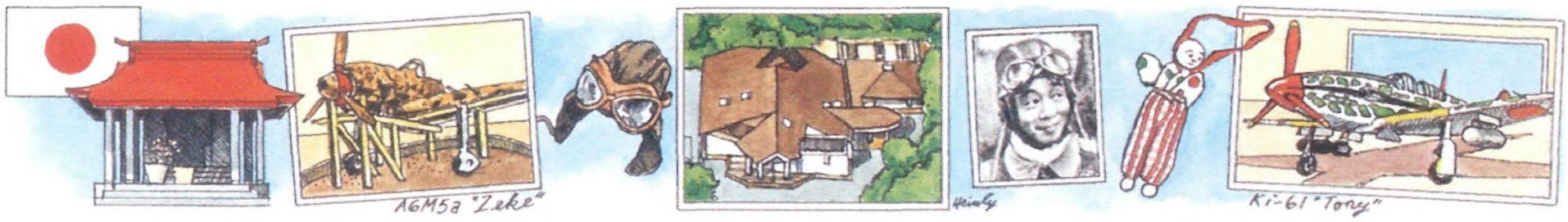


JOHN HEINLY

# Chapel of the Thunder Gods

These days, the phrase "death before dishonor" has a quaint ring, like something you'd come across only in the design catalog of a tattoo parlor. Yet half a century ago, several thousand young men, most of them in their teens and early 20s, took the adage literally, risking virtually certain death in the name of national honor. In the final months of World War II, these Japanese pilots were trained to destroy American ships and airplanes in the Pacific by flying headlong into them.

Perhaps in an attempt to shore up morale, Japanese commanders proclaimed the young pilots "Thunder Gods," declaring that after the thunderous explosion of their airplanes, the aviators would become divine spirits. The military also bestowed on the fliers the term *kamikaze*—"divine wind"—a reference to the typhoon winds that had saved the country from attacking Mongol fleets in the 13th century.

Today, the youthful sacrifice of the kamikazes is memorialized in a little-known Japanese museum called the Tokko Ihinkan (Peace Museum for Kamikaze Pilots), which is dedicated to the memory of the suicide pilots and to the loved ones they left behind.

The museum lies at the end of a long row of pretty white birch trees. Two white pillars at the entrance and a gently arched gray-tiled roof give the building the look of a chapel. The grounds are covered with white gravel and landscaped with cherry trees, pensive green pines, and Japanese maples, which turn deep red in the fall.

Inside, display cases hold such kamikaze artifacts as compasses, binoculars, goggles, notebooks, diaries, wristwatches, and hand-made dolls given to the pilots by their young sisters. Lining the museum's walls, softly lit by ceiling lights, are hundreds of black-and-white photographs of the young pilots, each with a name and a date of death. One of the most poignant shows five pilots holding a puppy. All the labels in the museum are in Japanese, but a foreign visitor will have no problem reading the emotion in the eyes of the pale young men as they gamely pose for a last toast before climbing into what were essentially flying coffins.

The aircraft most commonly used in the kamikaze flights was the infamous Mitsubishi A6M Zero fighter, which the Allies called the "Zeke" (Japanese aircraft were often given Western nicknames). One of the museum's most dramatic displays is a model A6M5a Zeke that was recovered from Teuchi Harbor, near Kagoshima. Though severely corroded, it is exhibited in the center of a simple, sunlit gallery that brings out the artifact's sculptural beauty. Two other fighters are on display: a Kawasaki Ki-61 "Tony" and a Nakajima Ki-84 "Frank," considered the nation's best World War II fighter.

*Tokko Ihinkan, Kori 17881, Chiran-cho, Kawanabe-gun, Kagoshima Prefecture. Phone (0993) 83-2525. Open 9 a.m.–5 p.m. daily. Admission: adults, 310 yen (about $2.75); kids, 205 yen.*

As the war progressed and Japan became more desperate, the nation unleashed the Ohka (Japanese for "cherry blossom"). The Ohka was a little wood-and-metal kamikaze airplane armed with a ton of explosives in its nose; it was carried aloft under the belly of a twin-engine Mitsubishi G4M "Betty" bomber. During a mission, the Ohka pilot would ride in the Betty until the target was within 25 to 50 miles. He would then climb through the Betty's bomb bay into the Ohka, pull a release handle, and be on his way.

Though the little aircraft was primitive, it had a compass, an altimeter, an airspeed indicator, an inclinometer, and a switch for firing the propulsion rockets in its tail. By the time the Ohka rammed into an American ship, it would have attained a speed of 600 mph. Before impact, the pilot would pull a handle to arm the fuse of the nose explosives.

Prior to kamikaze missions, Japanese pilots vowed to take a battleship for every aircraft, but in fact, personnel on American ships blasted most of the kamikazes out of the sky with anti-aircraft fire before the pilots reached their targets. No historian has ever determined exactly how many Japanese airmen perished in suicide attacks and under what circumstances. Eventually, every pilot in Japan's military was taught how to ram attacking bombers, and some pilots died in individual, spontaneous attacks that went undocumented.

Japanese young people who visit the museum today find the experience a thought-provoking one. Satsuki Watanabe of Kagoshima City says she visits the museum whenever she is in the area: "I have heard that most of the pilots didn't think the war was necessary, but they felt compelled to defend their country," she says. "In history, I read that a lot of Japanese people thought the war was a bad thing, but they had to do it."

There's no question that the suicide missions aroused complex feelings in the young kamikazes (see "My Body Will Collapse Like a Falling Cherry Blossom," Apr./May 1991). Some of the museum's artifacts hint at the fliers' torment. Letters bidding farewell to mothers, fathers, and sweethearts convey the writers' great sadness at having to die young, as well as their devotion to both family and homeland.

Before the first Ohka mission, staged on March 21, 1945, the pilots took fingernail and hair clippings and put them in boxes so that their parents would have something for funeral services. Each then wrote out a statement. One kamikaze pilot's read: "May our death be as sudden as the shattering of crystal." Eighteen Betty bombers carrying 15 Ohkas took off from Kanoya Air Base; they were accompanied by a protective flight of 30 fighters. But before the Ohkas could be released, 50 American F6F Hellcats pounced on the fleet. At the end of the engagement, 160 Japanese—including all 15 of the mission's Thunder Gods—were dead.

*—Steven Knipp*


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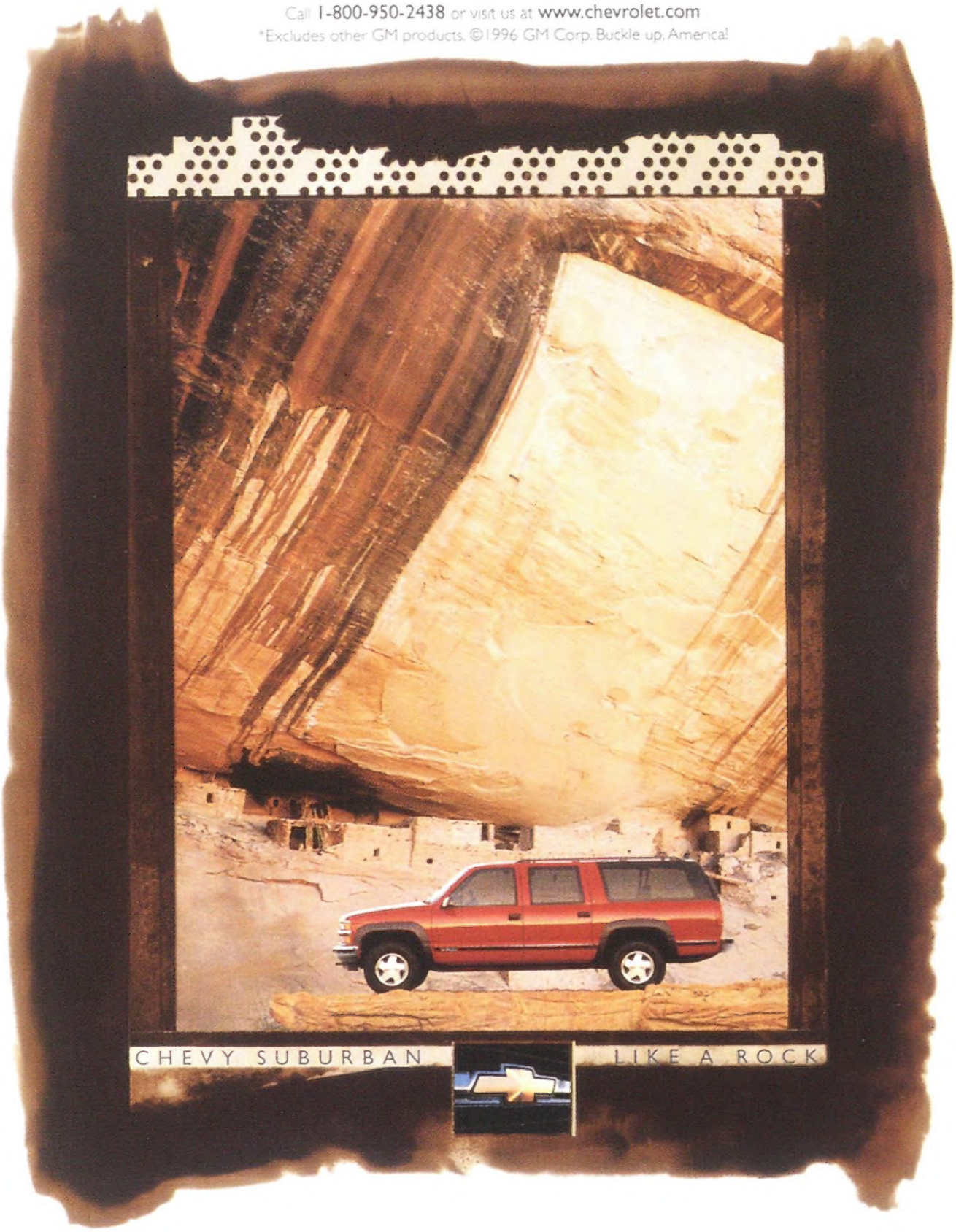


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